Section I—Air and Fallout

GROSS BETA ACTIVITY IN AIRBORNE PARTICULATES AND PRECIPITATION

Continuous surveillance of gross beta activity in air and precipitation provides one of the earliest and most sensitive indications of changes in environmental fission product activity. Although this surveillance does not provide enough information to assess human radiation exposure from fallout, it is used as an alerting system for determining when to intensify monitoring in other phases of the environment.

Surveillance data from a number of national programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. Data provided by programs of the Public Health Service, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization are presented individually in tabular form.

1. Radiation Surveillance Network February 1965

Division of Radiological Health, Public Health Service

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Surveillance Network (RSN) of the PHS Division of Radiological Health, which regularly gathers samples from 75 stations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

Alerting function

The alerting function of the network is provided by field estimates of the gross beta activity of airborne particulates on the filters. These determinations are performed about 5 hours after the end of the sampling period to allow for decay of naturally occurring radon daughters. The network station operators regularly submit their field estimates to the Radiation Surveillance Center, Division of Radiological Health, Washington, D. C. These field estimates are reported elsewhere on a monthly basis (*1*). When unusually high air levels are reported, appropriate Federal and State officials are promptly notified.

Air sampling procedure and results

Airborne particulates are collected continuously on carbon-loaded cellulose dust filters 4 inches in diameter. About 1800 cubic meters of air is drawn through each filter during the 24-hour sampling period by a high volume centrifugal blower.

The filters are forwarded to the Radiation Surveillance Network laboratory in Rockville, Maryland, where the gross beta activity is measured using a thin-window, gas-flow proportional counter, calibrated with a ^{90}Sr–^{90}Y standard. Each filter is counted 4 days after the end of the sampling period and again 7 days later if the net count rate is 2,000 cpm or higher. The initial 4-day aging of the sample eliminates intereference from naturally occurring radon and thoron daughters. By using the two counts and the Way-Wigner formula (*2*),

FIGURE 1.—RADIATION SURVEILLANCE NETWORK SAMPLING LOCATIONS

the age of fission products is estimated, and the activity extrapolated to the time of collection.[1] The daily concentrations and estimated ages of selected samples are reported by the PHS in a monthly RSN report (*1*). Table 1 presents average gross beta concentrations in air determined from February 1965 RSN air filters.

Time profiles of gross beta activity in air dating back to 1958 for eight RSN stations are shown in figure 2.

During February 1965, two air samples were analyzed by gamma spectroscopy. The method discussed by Burrus (*3*) and Covell (*4*) was adapted for resolving the complex gamma scan data. No air or precipitation samples were found to contain short-lived radionuclides.

Precipitation measurements

Continuous sampling for radioactivity in total precipitation is conducted at most stations on a daily basis, using funnels with collection areas of 0.4 square meter. A 500-ml portion of the collected precipitation is evaporated to dryness, and the residue is forwarded to the laboratory for analysis. If the collected sample is between 200 and 500 ml, the entire sample is evaporated. When a sample is smaller than 200 ml (equivalent to 0.5 mm or 0.02 inches of rainfall), the volume of precipitation is reported, but no analysis is made.

In the laboratory the gross beta activity in precipitation is determined by counting the evaporated sample by the same method used for analyzing the air filters, including the extrapolation to time of collection. Deposition for the sample is determined by:

$$D = \frac{CP}{1000}$$

where D is the deposition in nCi/m², C is the concentration in pCi/liter, and P is the depth of precipitation in mm. The individual values of deposition and depth of precipitation are totaled for the month. The February 1965 depths and total depositions are given in table 1.

[1] If a sample contains a mixture of fresh and old fission products, the age estimated by the Way-Wigner formula is some intermediate value; consequently the calculated age of the fresh component will be overestimated.

TABLE 1.—GROSS BETA ACTIVITY IN SURFACE AIR AND PRECIPITATION, FEBRUARY 1965

Station location		Air surveillance					Precipitation measurements	
		Number of samples	Gross beta activity, pCi/m³			Last profile in *RHD*	Total depth (mm)	Total deposition nCi/m²
			Maximum	Minimum	Average [a]			
Ala:	Montgomery	27	0.59	<0.10	0.28	May 65	177.7	48.3
Alaska:	Adak	17	0.52	<0.10	<0.16	Nov 64	[b]	[b]
	Anchorage	27	0.31	<0.10	0.19	May 65	6.2	1.3
	Attu Island	3	0.26	<0.10	<0.15	Dec 64		
	Fairbanks	15	0.24	<0.10	0.15	Jun 65	9.0	1.8
	Juneau	3	0.10	<0.10	<0.10	Sep 64		
	Kodiak	17	0.46	<0.10	<0.19	Oct 64		
	Nome	23	0.32	<0.10	0.18	Feb 65		
	Point Barrow	27	0.38	<0.10	<0.13	Jan 65		
	St. Paul Island	27	0.28	<0.10	<0.15	Mar 65		
Ariz:	Phoenix	25	0.52	<0.10	0.32	Sep 64		
Ark:	Little Rock	24	0.35	<0.10	0.20	Jun 65	115.6	23.2
Calif:	Berkeley	26	0.43	<0.10	0.20	Oct 64	24.0	4.8
	Los Angeles	28	0.73	<0.10	0.35	Feb 65	8.4	1.7
C. Z:	Ancon	14	0.15	<0.10	<0.11	Nov 64		
Colo:	Denver	25	0.52	<0.10	0.26	Oct 64	6.5	1.4
Conn:	Hartford	26	0.53	<0.10	0.26	Oct 64	77.0	16.6
Del:	Dover	19	0.50	<0.10	0.34	May 65		
D. C:	Washington	25	0.63	<0.10	0.31	Feb 65	46.3	9.3
Fla:	Jacksonville	25	0.70	<0.10	0.23	Jun 65	175.2	37.0
	Miami	27	0.67	<0.10	0.31	Oct 64	98.8	21.6
Ga:	Atlanta	28	0.46	<0.10	<0.18	Apr 65	49.8	10.0
Guam:	Agana	27	0.41	<0.10	0.21	Apr 65		
Hawaii:	Honolulu	28	0.51	<0.10	0.30	Dec 64	34.2	6.9
Idaho:	Boise	27	0.38	<0.10	0.20	Dec 64	9.9	3.7
Ill:	Springfield	27	0.63	<0.10	0.27	Feb 65		
Ind:	Indianapolis	25	0.49	<0.10	0.25	Apr 65	96.6	19.1
Iowa:	Iowa City	27	0.51	<0.10	0.28	Nov 64	23.8	5.0
Kans:	Topeka	26	0.36	<0.10	0.18	May 65	21.0	4.3
Ky:	Frankfort	24	0.53	<0.10	0.34	Feb 65	38.2	8.6
La:	New Orleans	27	0.28	<0.10	0.16	Feb 65	118.7	27.7
Maine:	Augusta	27	0.51	0.21	0.32	Mar 65	132.1	27.8
	Presque Isle	4	0.41	<0.10	0.28	Nov 64		
Md:	Baltimore	18	0.46	<0.10	0.26	Oct 64	27.5	5.5
	Rockville	5	0.39	0.13	0.22	Jan 65		
Mass:	Lawrence	25	0.50	<0.10	0.30	May 65	53.6	11.9
	Winchester	24	0.66	0.13	0.38	Dec 64	58.3	15.3
Mich:	Lansing	28	0.70	0.17	0.35	Jan 65		
Minn:	Minneapolis	21	0.30	<0.10	0.17	Apr 65	38.1	7.6
Miss:	Jackson	27	0.45	<0.10	0.22	Mar 65	108.4	24.9
	Pascagoula	17	0.46	<0.10	0.25	Dec 64		
Mo:	Jefferson City	27	0.35	<0.10	0.17	Apr 65	25.9	5.3
Mont:	Helena	28	0.53	<0.10	0.25	Nov 64	12.2	2.5
Nebr:	Lincoln	18	2.83	<0.10	0.34	Mar 65		
Nev:	Las Vegas	19	0.74	0.13	0.34	Jun 65		
N. H:	Concord	18	0.60	<0.10	0.32	Feb 65		
N. J:	Trenton	28	0.53	<0.10	0.29	Mar 65	13.3	2.9
N. Mex:	Santa Fe	24	0.59	<0.10	0.24	Nov 64	24.2	4.7
N. Y:	Albany	19	0.40	<0.10	0.25	Apr 65	28.6	5.9
	Buffalo	19	0.66	0.15	0.35	Nov 64		
	New York	22	0.96	<0.10	0.39	Dec 64		
N. C:	Gastonia	28	0.76	<0.10	0.35	Nov 64	87.2	18.2
N. Dak:	Bismarck	27	0.30	<0.10	0.17	Jan 65	2.5	0.5
Ohio:	Cincinnati	17	0.71	<0.10	0.26	May 65		
	Columbus	24	0.84	<0.10	0.42	Mar 65	66.6	13.4
	Painesville	27	0.77	0.14	0.37	Oct 64	55.5	17.0
Okla:	Oklahoma City	23	0.37	<0.10	0.18	Jan 65	8.3	4.1
	Ponca City	23	0.28	<0.10	<0.12	Oct 64	15.4	3.6
Ore:	Portland	27	1.13	<0.10	0.30	Mar 65	46.7	10.1
Pa:	Harrisburg	27	0.52	<0.10	0.24	Apr 65	17.8	7.0
P. R:	San Juan	22	0.36	<0.10	0.17	Mar 65	34.4	9.6
R. I:	Providence	28	0.50	<0.10	0.30	Jan 65	95.1	19.3
S. C:	Columbia	26	0.54	<0.10	0.28	Dec 64	137.0	33.9
S. Dak:	Pierre	27	0.38	<0.10	0.17	Sep 64		
Tenn:	Nashville	28	0.53	<0.10	0.30	Jan 65	117.2	24.4
Tex:	Austin	27	0.49	<0.10	0.21	May 65	146.8	33.0
	El Paso	27	0.72	0.18	0.40	Jan 65	10.5	2.2
Utah:	Salt Lake City	27	1.08	<0.10	0.30	Feb 65	23.9	5.3
Vt:	Barre	26	0.62	0.13	0.39	Jun 65	41.8	9.2
Va:	Richmond	28	0.35	<0.10	0.21	Jun 65	83.8	16.9
Wash:	Seattle	25	0.40	<0.10	<0.16	May 65	90.3	14.3
	Spokane	28	0.48	<0.10	0.18	Apr 65		
W. Va:	Charleston	27	0.62	<0.10	0.34	Dec 64	45.2	9.8
Wis:	Madison	27	0.58	<0.10	0.29	Jun 65	24.0	7.9
Wyo:	Cheyenne	28	0.53	<0.10	0.23	Jun 65	3.5	0.7
Network summary [c]		1,758	2.83	<0.10	<0.25		55.2	12.3

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values of <0.10 are assumed to be 0.10 for averaging purposes. If the <0.10 values represent more than 10 percent of the values used in the average, a less-than sign is placed before the average.

[b] Blank indicates no report received.

[c] For the network summary, all averages are arithmetic means of station averages.

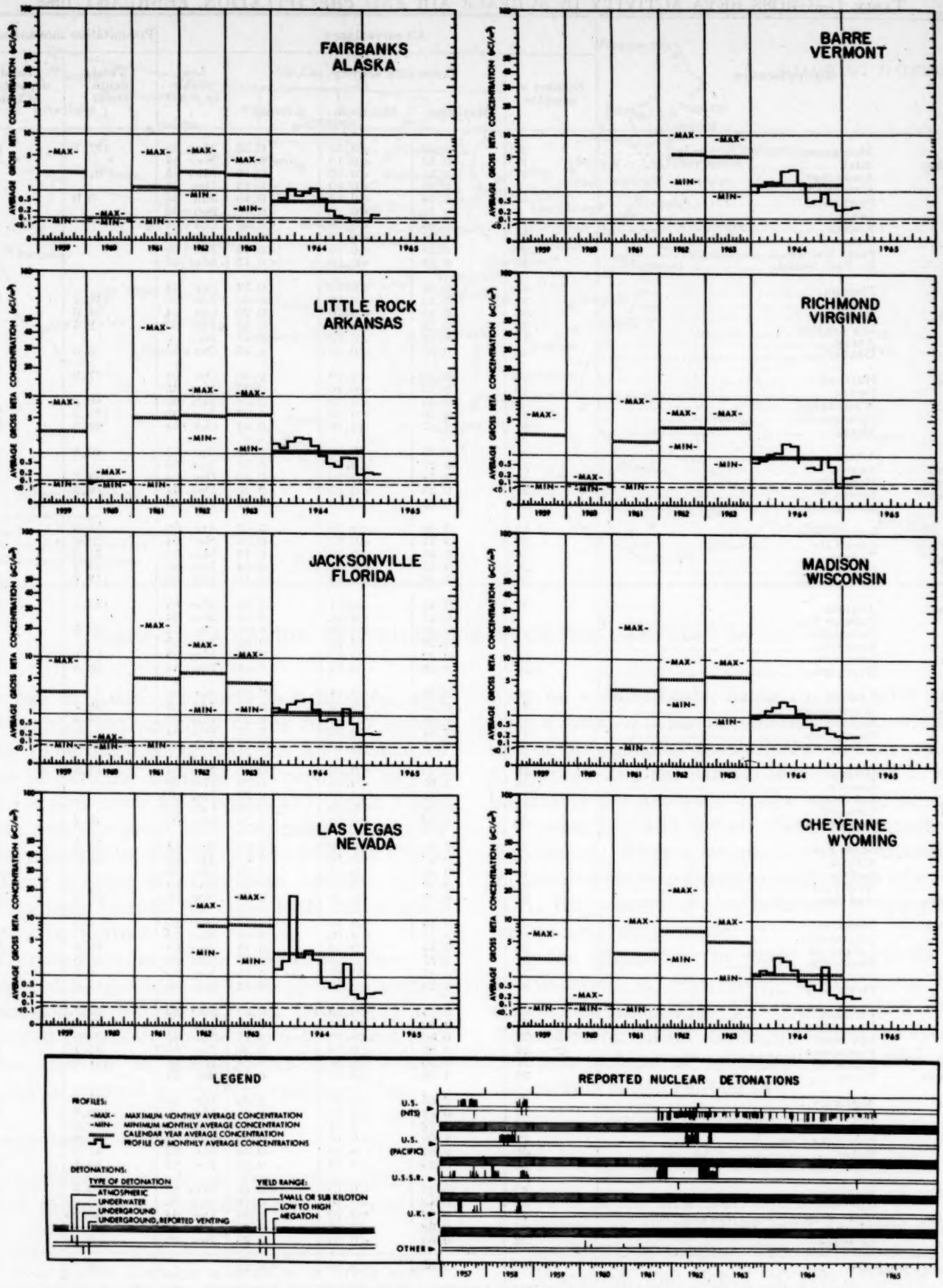

FIGURE 2.—MONTHLY AND YEARLY PROFILES OF BETA ACTIVITY IN AIR—RADIATION SURVEILLANCE NETWORK, 1959–FEBRUARY 1965

2. Canadian Air Monitoring Program[2] February 1965

Department of National Health and Welfare

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (see figure 3), where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*5-9*).

Air

Each air sample involves the collection of particulates from about 650 cubic meters of air drawn through a high-efficiency 4-inch diameter glass-fiber filter during a 24-hour period. These filters are sent daily to the Radiation Protection Division Laboratory in Ottawa. At the laboratory, a 2-inch-diameter disk is cut from each filter and counted with a thin-end-window, gas-flow, Geiger-Mueller counter system calibrated with a ^{90}Sr–^{90}Y standard. Four successive measurements are made on each filter to permit correction for natural activities and for the decay of short-lived fission products. The results are extrapolated to the end of the sampling period. Canadian air data for February 1965 are given in table 2.

Precipitation

The amount of radioactive fallout deposited on the ground is determined from measurements on material collected in special polyethylene-lined rainfall pots. The collection period for each sample is one month. After transfer of the water to the sample container, the polyethylene liner is removed, packed with the sample, and sent to the laboratory.

Strontium and cesium carriers are added to all samples on arrival at the laboratory. Other carriers are also added to selected samples according to the specific radionuclides to be determined. The samples are then filtered and the filtrate evaporated to near dryness. The filter paper containing insoluble matter is ignited together with the polyethylene liner at 450 degrees C. The ash is combined with the soluble fraction, transferred to a glass planchet, evaporated under an infra-red lamp, and then counted with a thin-end-window Geiger-Mueller counter calibrated with a ^{90}Sr–^{90}Y source. Gross beta activities for February 1965 samples are given in table 2. Radionuclide analyses are reported quarterly in *RHD*.

[2] Data from RADIATION PROTECTION DIVISION. *Radiation Protection Programs*, Vol. 3, No. 3: 16–24 (March 1965), Canadian Department of National Health and Welfare, Ottawa, Canada.

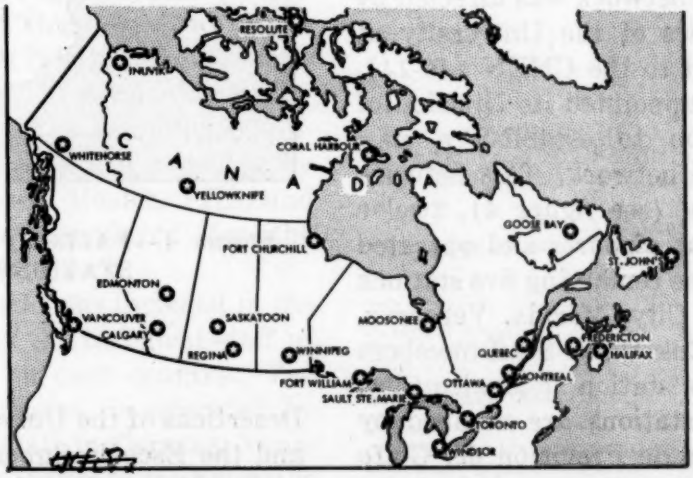

FIGURE 3.—CANADIAN AIR AND PRECIPITATION SAMPLING STATIONS

TABLE 2.—GROSS BETA ACTIVITY IN SURFACE AIR AND PRECIPITATION, CANADA, FEBRUARY 1965

Station location	Air surveillance				Precipitation measurements	
	Number of samples	Gross beta activity, pCi/m³			Average concentration, pCi/liter	Total deposition nCi/m³
		Maximum	Minimum	Average		
Calgary	28	0.5	0.0	0.2	221	3.6
Coral Harbour	28	0.3	0.0	0.2	373	1.7
Edmonton	28	0.3	0.1	0.2	149	3.9
Ft. Churchill	17	0.4	0.1	0.2	151	1.3
Ft. William	28	0.5	0.2	0.3	118	5.8
Fredericton	28	0.3	0.1	0.2	49	3.4
Goose Bay	28	0.4	0.1	0.2	47	2.3
Halifax	28	0.3	0.1	0.2	46	5.2
Inuvik	28	0.4	0.1	0.3	190	1.4
Montreal	28	0.4	0.2	0.3	81	6.0
Moosonee	28	0.4	0.1	0.3	43	1.5
Ottawa	27	0.4	0.1	0.3	66	5.7
Quebec	28	0.4	0.1	0.3	109	14.4
Regina	28	0.4	0.1	0.2	81	2.7
Resolute	26	0.3	0.0	0.2	43	3.0
St. John's, Nfld	28	0.4	0.0	0.2	66	5.4
Saskatoon	14	0.2	0.1	0.1	88	1.4
Sault Ste. Marie	26	0.6	0.0	0.3	77	6.3
Toronto	28	0.5	0.1	0.3	81	6.3
Vancouver	28	0.4	0.0	0.1	110	19.7
Whitehorse	28	0.4	0.1	0.2	45	0.9
Windsor	27	0.5	0.1	0.3	46	4.2
Winnipeg	27	0.4	0.2	0.2	209	2.9
Yellowknife	28	0.4	0.1	0.2	117	0.8
Network summary	640	0.4	0.0	0.2	112	4.6

3. Mexican Air Monitoring Program February 1965

National Commission of Nuclear Energy

The Radiation Surveillance Network of Mexico was established by the Comisión Nacional de Energía Nuclear (CNEN), Mexico City. From 1952 to 1961 the network was directed by the Institute of Physics of the University of Mexico, under contract to the CNEN (*10-14*).

In 1961 the CNEN appointed its Division of Radiological Protection to establish a new Radiation Surveillance network. This network consists of 17 stations (see figure 4), twelve of which are located at airports and operated by airline personnel. The remaining five stations are located at Mexico City, Mérida, Veracruz, San Luis Potosí, and Ensenada. Staff members of the DRP operate the station at Mexico City, while the other four stations are manned by members of the Centro de Previsión del Golfo de México, the Chemistry Department of the University of Mérida, the Institute de Zonas Desérticas of the University of San Luis Potosí, and the Escuela Superior de Ciencias Marinas of the University of Baja California, respectively.

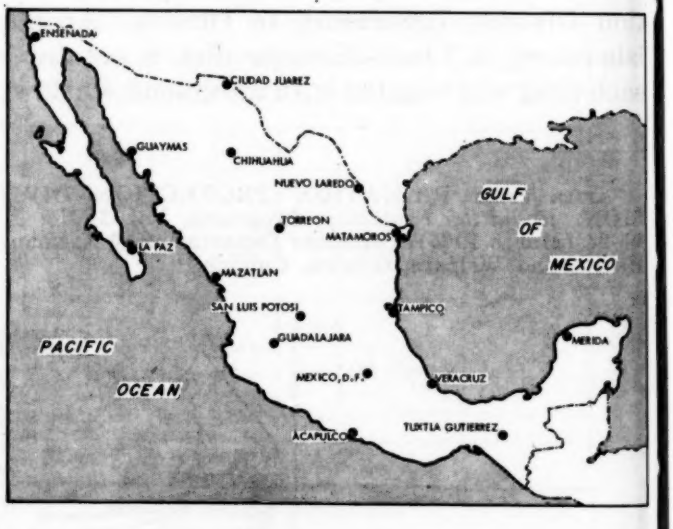

FIGURE 4.—FALLOUT NETWORK SAMPLING STATIONS IN MEXICO

Sampling

The sampling procedure involves drawing air for 24-hours a day, 3 or 4 days a week at the rate of approximately 1,200 cubic meters per day, through a high-efficiency, 6 x 8-inch glass fiber filter, using high volume samplers. After each 24-hour sampling period, the filter is removed and forwarded via airmail to the "Laboratorio de Estudios sobre Contaminación Radiactiva", CNEN, in Mexico City for assay of gross beta activity. A minimum of 3 or 4 days after collection is allowed for decay of radon and thoron daughter natural radioactivity. Data are not extrapolated to time of collection.

Results

The maximum, minimum, and average fission product beta concentrations in surface air during February 1965 are presented in table 3.

TABLE 3.—GROSS BETA ACTIVITY OF AIRBORNE PARTICULATES, MEXICO, FEBRUARY 1965

Station	Number of samples	Gross beta activity, pCi/m³		
		Maximum	Minimum	Average
Acapulco	5	[a]	<0.1	0.1
Ciudad Juárez	7	0.2	0.1	0.1
Chihuahua	9	0.4	<0.1	0.2
Ensenada	3	0.2	0.1	0.1
Guadalajara	3	0.1	<0.1	0.1
Guaymas	0			
La Paz	0			
Matamoros	2	<0.1	<0.1	<0.1
Mazatlán	0			
Mérida	5	0.1	<0.1	0.1
México, D.F.	5	0.1	<0.1	0.1
Nuevo Laredo	4	0.1	<0.1	<0.1
San Luis Potosí	12	0.2	0.1	0.1
Tampico	13	0.9	<0.1	0.2
Torréon	13	0.5	0.1	0.2
Tuxtla Gutiérrez	0			
Veracruz	5	0.3	<0.1	0.1

[a] Blanks indicate stations temporarily shut down.

4. Pan American Air Sampling Program February 1965

Pan American Health Organization and Public Health Service

Gross beta activity in air is monitored by five countries in the Americas under the auspices of a collaborative program, developed by the Pan American Health Organization and the Public Health Service (PHS), for assisting countries of the Americas in developing radiological health programs. The sampling equipment and analytical services are provided by the Division of Radiological Health, PHS, and are identical with those employed for the Radiation Surveillance Network.

The five air sampling stations included in the Program are operated by the technical staff of the Ministry of Health in each country. The station in Kingston, Jamaica, is operated by the Public General Hospital; in Caracas, Venezuela, by the Venezuelan Institute for Scientific Investigations; in Lima, Peru, by the Institute of Occupational Health; in Santiago, Chile, by the Occupational Health Service; and in Trinidad, West Indies, by the University of the West Indies.

The February 1965 air monitoring results from the five participating countries are given in table 4.

TABLE 4.—GROSS BETA ACTIVITY IN AIR, PAHO, FEBRUARY 1965

Sampling stations	Number of samples	Gross beta activity, pCi/m³		
		Maximum	Minimum	Average [a]
Kingston, Jamaica	8	0.16	<0.10	0.12
Caracas, Venezuela	20	0.11	<0.10	<0.10
Lima, Peru	8	0.22	<0.10	<0.12
Santiago, Chile	27	0.39	<0.10	<0.14
Trinidad, West Indies	15	0.17	<0.10	<0.11

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values of <0.10 are assumed to be 0.10 for averaging purposes. If the <0.10 values represent more than 10 percent of the values used in the average, a less-than sign is placed in front of the average.

5. Gross Beta Activity in Air, North America February 1965

From January 1963 through March 1965, monthly average concentrations of airborne gross beta activity in Canada and the United States were presented in combined form as isogram maps of most of North America. The data from the Radiation Surveillance Network and the Canadian Air Network were adjusted to each other by means of an intercalibration factor derived by Lockhart and Patterson (*15*).

With the formation of the Mexican Air monitoring program, new intercalibration ratios were determined, this time including the Canadian Network, Radiation Surveillance Network, Pan American Air Sampling Program, National Air Sampling Network, the HASL 80th Meridian Network, and the Mexican Network (*16*). The new intercalibration factors reflect some changes in standardization in both the RSN and the Canadian Air Network, effective September 1963.

In recent months, airborne gross beta activities have declined to such low levels that isogram comparisons are no longer meaningful. Before comparison with each other, the data must be multiplied by appropriate intercalibration factors. For example, if the Canadian data are considered as unity, the RSN and Pan American data must be multiplied by the intercalibration factor, 1.28, and the Mexican data must be multiplied by 0.81.

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FISSION PRODUCT GAMMA ACTIVITY IN SURFACE AIR—80th MERIDIAN AND U.S. LOCATIONS, JULY–NOVEMBER 1964[1]

Health and Safety Laboratory
Atomic Energy Commission

Since January 1, 1963, surface air filter samples have been collected for total gamma activity determinations as part of the HASL (Health and Safety Laboratory) 80th Meridian Network program. This network consists of fourteen air sampling stations near the 80th Meridian (West) from Thule, Greenland, to Punta Arenas, Chile (figure 1). An additional station at Mauna Loa, Hawaii, is included for comparison of data with the Chacaltaya, Bolivia station. These stations are both at high elevations and are at approximately equal north and south latitudes, respectively.

In August 1963, six additional air sampling stations were added to the HASL Network in North America (*1*). As with the original 80th Meridian Network sampling stations, both air filter and deposition samples are collected. While surface air data are reported on a monthly basis, the deposition data are reported quarterly.

Sampling and analysis procedures

Air particulates are sampled on 8-inch-diameter polystyrene (Microsorban) filters, drawing air through the filters continuously at the rate of about 1,400 cubic meters per day. Filters are changed on the 1st, 8th, 15th, and 22nd of each month and forwarded to HASL for analysis. A total gamma count over the energy range, 0–3 Mev, is made approximately two weeks after the end of the sampling period, using an 8 x 4-inch sodium iodide (thallium-activated) crystal. The filters are then composited on a monthly basis and analyzed radiochemically, together with monthly ground deposition samples taken at the same site, for detectable fission and neutron activation products.

Results and discussion

The results of total gamma activity determinations in weekly ground level air filter samples taken at 80th Meridian Network stations during July through November 1964 are given in tables 1–5, together with average monthly activity concentrations calculated for each site. The average monthly activities are also plotted in figures 2–4 as activity-latitude profiles.

There was a marked decrease in gamma activity in July 1964 at most stations. Surface air activities in the Northern Hemisphere ranged from 0.03 to 1.02 γ/min/m^3 (photons per minute per cubic meter) and averaged 0.43 γ/min/m^3. In the Southern Hemisphere, the range was from 0.01 to 0.09 γ/min/m^3. In comparison with previous data, the July 1964 averages represent a 42 percent decrease in the

FIGURE 1.—80TH MERIDIAN NETWORK SAMPLING STATIONS

[1] This report was developed from information and data in the November 1964 through March 1965 monthly reports entitled "80th Meridian Network, Results of Air Sampling Measurements." These reports are furnished by the Health and Safety Laboratory, AEC, New York, N. Y. 10014

Northern Hemisphere and less than a 3 percent decrease in the Southern Hemisphere with respect to the previous month. The July 1964 gamma activity concentrations expressed in terms of the respective July 1963 average levels were 0.12 of those observed in the Northern Hemisphere and 0.38 of those observed in the Southern Hemisphere.

TABLE 1.—GAMMA ACTIVITY IN SURFACE AIR, JULY 1964

[Gamma activity, photons/min/m³]

Sampling site	Date filter changed				
	8	15	22	31	Average
Thule	0.0946	0.103	0.184	0.0993	0.115
Moosonee	0.956	0.684	0.538	0.531	0.675
New York	0.936	0.488	0.617	0.332	0.606
Washington	0.489	0.502	1.02	0.274	0.543
Miami	0.385	0.460	0.333	0.276	0.345
Mauna Loa	0.386	0.372	0.311	0.283	0.332
San Juan	0.417	0.359	0.441	0.400	0.404
Miraflores	0.0460	0.0530	0.115	0.0274	0.0571
Guayaquil	0.0255	0.0228	0.0259	0.0344	0.0278
Lima	0.0229	0.0558	0.0602	0.0525	0.0473
Chacaltaya	0.0911	0.0609	0.0229	0.0570	0.0566
Antofagasta	0.0590	0.0659	0.0674	0.0867	0.0713
Santiago	0.0333	0.0302	0.0191	0.0133	0.0238
Puerto Montt	0.0306	0.0166	0.0103	0.0175	0.0187
Punta Arenas	0.0293	0.0163	0.0164	0.0114	0.0177
Additional U.S. Sites:					
Westwood					0.474
Chattanooga					0.505
Appleton					0.568
Midwest City					0.645
Palo Alto					0.437
Seattle					0.266

In August 1964, the surface air activities in the Northern Hemisphere ranged from 0.02 to 0.48 γ/min/m³ and averaged 0.28 γ/min/m³. In the Southern Hemisphere, the range was from 0.01 to 0.12 γ/min/m³ with an average of 0.04 γ/min/m³. In comparison with the previous month, the activities in the Northern Hemisphere decreased by 35 percent while those in the Southern Hemisphere increased about 20 percent. Relative to the August 1963 levels, the August 1964 levels were 0.11 and 0.45 of the respective Northern and Southern Hemisphere average gamma activity concentrations.

The September 1964 surface air gamma activities in the Northern Hemisphere ranged from 0.03 to 0.62 γ/min/m³ and averaged 0.18 γ/min/m³. In the Southern Hemisphere, the range was from 0.01 to 0.09 γ/min/m³, with an average of 0.064 γ/min/m³. In comparison with the previous month, the average surface air activities in the Northern Hemisphere decreased by 36 percent while in the Southern Hemisphere an increase of about 39 percent was noted. Relative to the September 1963 levels, the September 1964 levels were 0.16 and 0.71 of the respective Northern and Southern Hemisphere average gamma activity concentrations.

TABLE 2.—GAMMA ACTIVITY IN SURFACE AIR, AUGUST 1964

[Gamma activity, photons/min/m³]

Sampling site	Date filter changed				
	8	15	22	31	Average
Thule	0.542	0.498	0.569	0.302	0.467
Moosonee	0.294	0.301	0.113	0.285	0.253
New York	0.591	0.420	0.371	0.375	0.442
Washington	0.524	0.332	0.407	0.303	0.383
Miami	0.347	0.110	0.208	0.0967	0.198
Mauna Loa	0.212	0.129	0.180	0.113	0.155
San Juan	0.571	0.142	no sample	0.111	0.257
Miraflores	0.0313	0.0567	0.0699	0.0398	0.0479
Guayaquil	0.0218	0.0144	0.0338	0.0351	0.0271
Lima	0.0426	0.0834	0.0455	0.0782	0.0473
Chacaltaya	0.0760	0.0740	0.0541	0.0536	0.0630
Antofagasta	0.0107	0.0914	0.0811	0.0895	0.0919
Santiago	0.0865	0.0408	0.0387	0.0582	0.0543
Puerto Montt	0.0133	0.0104	0.0319	0.0204	0.0192
Punta Arenas	0.0168	0.0115	0.0171	0.0238	0.0179
Additional U.S. Sites:					
Westwood	0.623	0.526	0.440	0.302	0.452
Chattanooga	0.412	0.333	0.342	0.311	0.348
Appleton	0.387	0.323	0.339	0.274	0.325
Midwest City	0.284	0.411	0.315	0.276	0.317
Palo Alto	0.174	0.198	0.223	0.206	0.203
Seattle	0.167	0.105	0.157	0.214	0.161

TABLE 3.—GAMMA ACTIVITY IN SURFACE AIR, SEPTEMBER 1964

[Gamma activity, photons/min/m³]

Sampling site	Date filter changed				
	8	15	22	30	Average
Thule	0.233	0.259	0.405	0.337	0.309
Moosonee	0.265	0.141	0.196	0.0932	0.169
New York	0.364	0.336	0.330	0.173	0.281
Washington	0.427	0.295	0.310	0.164	0.290
Miami	0.178	0.138	0.135	0.0859	0.131
Mauna Loa	0.0811	0.197	0.145	0.0734	0.125
San Juan	0.170	0.108	0.0640	0.107	0.112
Miraflores	0.0257	0.0345	0.0248	0.0147	0.0243
Guayaquil	0.0256	0.0436	0.0481	0.0292	0.0367
Lima	0.113	0.118	0.102	0.0940	0.106
Chacaltaya	0.0752	0.0699	0.0618	0.0561	0.0650
Antofagasta	0.0818	0.112	0.0796	0.0736	0.0760
Santiago	0.106	0.0882	0.0923	0.0700	0.0882
Puerto Montt	0.0647	0.0557	0.0335	0.0244	0.0431
Punta Arenas	0.0364	0.0277	0.0139	0.0161	0.0231
Additional U.S. Sites:					
Westwood	0.368	0.315	0.288	0.150	0.271
Chattanooga	0.470	0.476	0.476	0.248	0.410
Appleton	0.236	0.233	0.184	0.188	0.209
Midwest City	0.235	0.303	0.121	0.204	0.214
Palo Alto	0.195	0.323	0.306	lost	0.272
Seattle	0.152	0.398	0.096	0.111	0.189

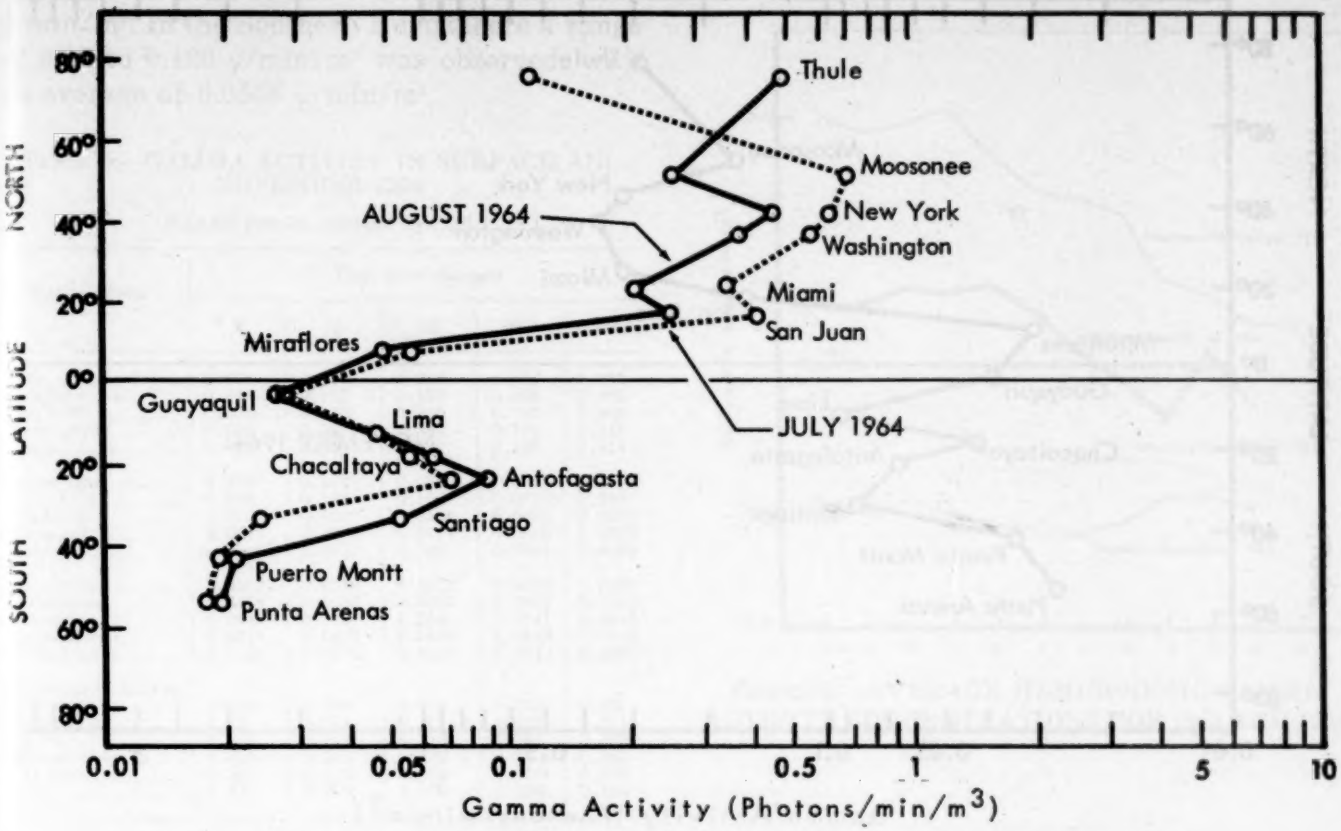

FIGURE 2.—PROFILE OF SURFACE AIR GAMMA ACTIVITY, 80TH MERIDIAN STATIONS, JULY AND AUGUST 1964

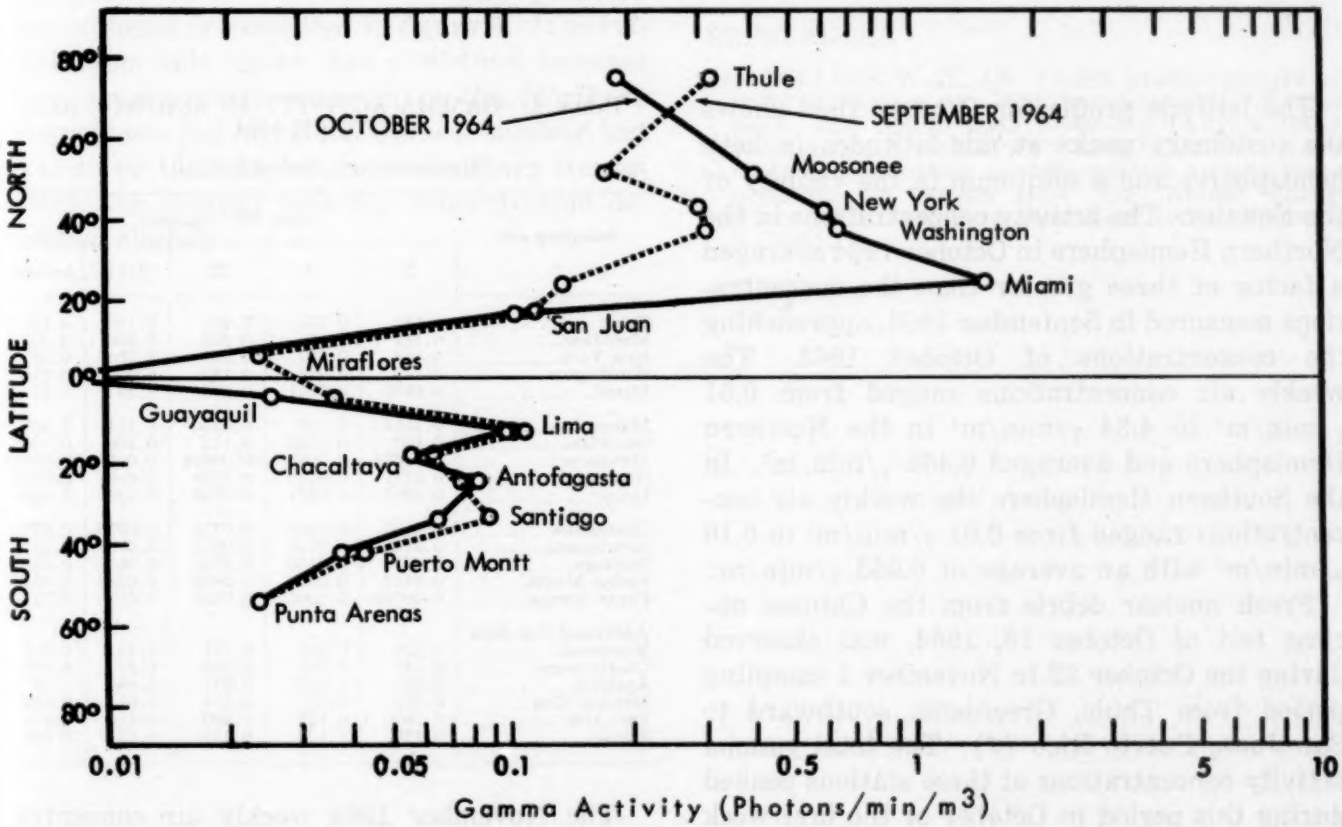

FIGURE 3.—PROFILE OF SURFACE AIR GAMMA ACTIVITY, 80TH MERIDIAN STATIONS, SEPTEMBER AND OCTOBER 1964

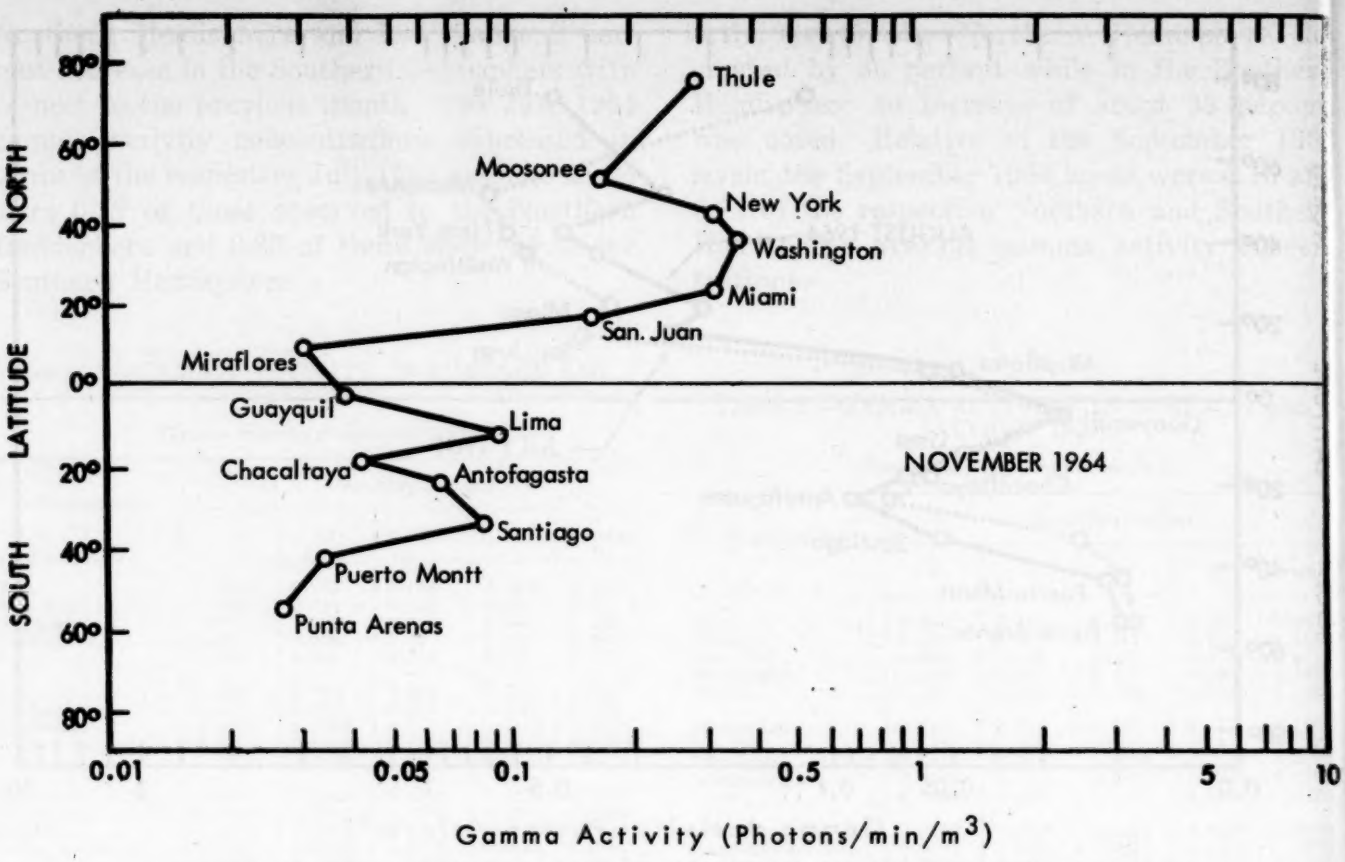

FIGURE 4.—PROFILE OF SURFACE AIR GAMMA ACTIVITY, 80TH MERIDIAN STATIONS, NOVEMBER 1964

The latitude profile for October 1964 shows the customary peaks at mid-latitudes in both hemispheres and a minimum in the vicinity of the Equator. The activity concentrations in the Northern Hemisphere in October 1964 averaged a factor of three greater than the concentrations measured in September 1964, approaching the concentrations of October 1963. The weekly air concentrations ranged from 0.01 γ/min/m^3 to 4.34 γ/min/m^3 in the Northern Hemisphere and averaged 0.455 γ/min/m^3. In the Southern Hemisphere the weekly air concentrations ranged from 0.01 γ/min/m^3 to 0.10 γ/min/m^3 with an average of 0.063 γ/min/m^3.

Fresh nuclear debris from the Chinese nuclear test of October 16, 1964, was observed during the October 22 to November 1 sampling period from Thule, Greenland, southward to San Juan, Puerto Rico (*2*). The total gamma activity concentrations at these stations peaked during this period in October or the first week in November, and then rapidly diminished with time (table 5).

TABLE 4.—GAMMA ACTIVITY IN SURFACE AIR, OCTOBER 1964

[Gamma activity, photons/min/m^3]

Sampling site	Date filter changed				
	8	15	22	1/11	Average
Thule	0.182	0.161	0.201	0.166	0.177
Moosonee	0.141	0.120	0.203	0.996	0.394
New York	0.184	0.272	0.250	2.036	0.591
Washington	0.179	0.225	0.180	0.65	0.615
Miami	0.0969	0.0841	0.225	4.34	1.45
Mauna Loa	0.0517	0.116	0.0380	0.474	0.303
San Juan	0.123	0.0553	0.112	0.109	0.100
Miraflores	0.00638	0.00931	0.00628	0.0120	0.00888
Guayaquil	0.0171	0.0143	0.0256	0.0401	0.0258
Lima	0.0861	0.0871	0.0759	0.135	0.0985
Chacaltaya	0.0365	0.0530	0.0730	0.0630	0.0566
Antofagasta	0.0723	0.0658	0.0819	0.0983	0.0810
Santiago	0.0774	0.0556	0.0730	0.0610	0.0652
Puerto Montt	0.0443	0.0200	0.0603	0.0282	0.0375
Punta Arenas	0.00765	0.0202	0.0502	0.0170	0.0231
Additional U.S. Sites:					
Westwood	0.206	0.248	0.177	1.45	0.625
Chattanooga	0.147	0.323	0.238	1.32	0.550
Appleton	0.232	0.217	0.331	3.68	1.27
Midwest City	0.232	0.273	0.314	2.01	0.836
Palo Alto	0.160	0.138	0.300	0.415	0.119
Seattle	0.179	0.155	0.155	0.665	0.299

The November 1964 weekly air concentrations in the Northern Hemisphere ranged from 0.02 to 1.22 γ/min/m^3 and averaged 0.210

γ/min/m^3. In the Southern Hemisphere a range of 0.02 to 0.120 γ/min/m^3 was observed, with an average of 0.0555 γ/min/m^3.

TABLE 5.—GAMMA ACTIVITY IN SURFACE AIR, NOVEMBER 1964

[Gamma activity, photons/min/m^3]

Sampling site	Date filter changed				
	8	15	22	12/1	Average
Thule	0.461	0.316	0.258	0.136	0.284
Kooosonee	0.272	0.152	0.134	0.108	0.165
New York	0.456	0.350	0.256	0.176	0.308
Washington	0.536	0.395	0.331	0.175	0.348
Miami	0.629	0.345	0.129	0.186	0.313
Mauna Loa	0.0397	0.0721	0.0780	0.0917	0.0718
San Juan	0.208	0.186	0.160	0.0725	0.155
Miraflores	0.0150	0.0202	0.0416	0.0430	0.0310
Guayaquil	0.0512	0.0388	0.0117	0.0516	0.0392
Lima	no sample	0.0751	0.120	0.0864	0.0933
Chacaltaya	0.0367	0.0279	0.0578	0.0478	0.0429
Antofagasta	0.0530	0.0657	0.0577	0.0856	0.0668
Santiago	0.0548	0.107	0.106	0.0747	0.0848
Puerto Montt	0.0224	0.0433	0.0360	0.0428	0.0346
Punta Arenas	0.0166	0.0274	0.0409	0.0340	0.0270
Additional U.S. Sites:					
Westwood	0.491	0.368	0.236	0.152	0.297
Chattanooga	1.22	0.614	0.201	0.222	0.511
Appleton	0.813	0.247	0.219	0.184	0 489
Midwest City	0.915	0.262	0.203	0.0806	0.362
Palo Alto	0.564	0.215	0.130	0.134	0.253
Seattle	0.328	0.200	0.100	0.108	0.184

A comparative plot of the monthly average concentrations in the Northern and Southern Hemispheres is presented in figure 5. It is evident from this figure that a distinct increase in gamma activity occurred in the Northern Hemisphere following the Chinese nuclear test of October 16, 1964, but in the Southern Hemisphere, the average monthly concentration decreased slightly.

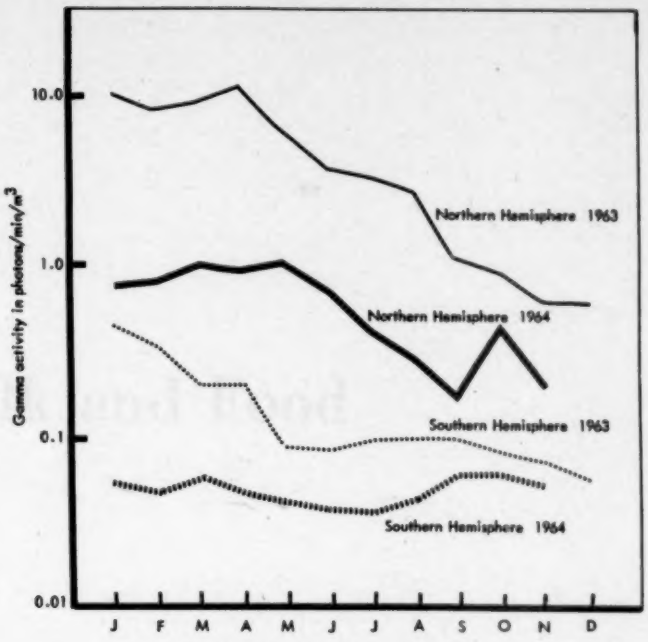

FIGURE 5.—AVERAGE HEMISPHERIC GAMMA ACTIVITY CONCENTRATIONS FOR 1963 AND 1964

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(1) COLLINS, W. R., JR. Fission product gamma activity in surface air—80th meridian and U.S. locations. Rad Health Data 5:360–362 (August 1964).
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Section II—Milk and Food

MILK SURVEILLANCE

Although milk is only one of the many sources of dietary intake of radionuclides, it is the single food item most often used as an indicator of the population's intake of radionuclides from the environment. This is because fresh milk is consumed by a large segment of the United States population and contains most of the radionuclides occurring in the environment which have been identified as biologically important. In addition, milk is produced and consumed on a regular basis, is convenient to handle, is easily analyzed, and samples representative of milk consumption in any area can be readily obtained.

1. Pasteurized Milk Network
February 1965

Division of Radiological Health and Division of Environmental Engineering and Food Protection, Public Health Service

The Public Health Service pasteurized milk surveillance program had its origin in a raw milk monitoring network (*1*) established by the Service in 1957. One of the primary objectives of the raw milk network was the development of methods for milk collection and radiochemical analysis suitable for larger scale programs.

Experience derived from this earlier network led to the activation of a pasteurized milk sampling program with stations selected to provide nationwide surveillance of milk production and consumption areas. The present network, which consists of 63 stations, has at least one station in every State, the Canal Zone, and Puerto Rico.

Sampling procedure

Through the cooperation of State and local milk sanitation authorities, samples are routinely collected at each station. The method specifies that each station's sample be composited of subsamples from each milk processing plant in proportion to the plant's average sales in the community served. At most stations the sample represents from 80 to 100 percent of the milk processed. Prior to September 15, 1961, the composite sample was taken from one day's sales per month and was as representative of the community's supply as could be achieved under practical conditions. Beginning with the resumption of nuclear weapons testing in the atmosphere in September 1961, and continuing through January 1963, samples were collected twice a week at nearly all stations and daily for short periods at selected stations. Since then, the sampling frequency has been reduced to once a week.

Samples are preserved with formaldehyde and are sent to the PHS Southwestern (SWRHL), Southeastern (SERHL), or Northeastern Radiological Health Laboratories (NERHL) for analysis. Gamma analyses for iodine–131 are made within 3 to 6 days after sample collection, and any results exceeding 100 pCi/liter are immediately telephoned to State health officials for possible public health action. Analytical results are normally available 6 to 7 weeks after monthly samples are received by the laboratories; publication in *RHD* follows 3 to 4 months after the monthly samples are composited for analyses.

Analytical procedures

Iodine–131, cesium–137, and barium–140 concentrations are determined by gamma scintillation spectroscopy.[1] After the weekly samples are gamma scanned, samples from two consecutive weeks are composited and analyzed radiochemically for strontium–89 and strontium–90. There is an inherent statistical variation associated with all measurements of radionuclide concentrations. With the low radionuclide levels which are usually found in milk and other environmental samples, this variation on a percentage basis is relatively high. The variation depends upon such factors as the method of chemical analysis, the sample counting rate and counting time, interferences from other radionuclides, and the background count. For milk samples, counting times of 50 minutes for gamma spectroscopy and 30 to 50 minutes for beta determinations are used. Table 1 shows the approximate total analytical error (including counting error) associated with radionuclide concentrations in milk. These errors were determined by comparing results of a large number of replicate analyses.

The minimum detectable concentration is defined as the measured concentration at which the two-standard deviation analytical error is equal to the measurement. Accordingly, the minimum detectable concentrations in units of pCi/liter are ^{89}Sr, 5; ^{90}Sr, 2; ^{137}Cs, 10; ^{140}Ba, 10; and ^{131}I, 10. At these levels and below the counting error comprises nearly all of the analytical error.

[1] Southeastern Radiological Health Laboratory employs a radiochemical procedure for barium–140 analysis.

TABLE 1.—ANALYTICAL ERRORS ASSOCIATED WITH ESTIMATED CONCENTRATIONS FOR SELECTED RADIONUCLIDES IN MILK

Nuclide	Estimated concentration (pCi/liter)	Error [a] (pCi/liter)	Estimated concentration (pCi/liter)	Error [a] (percent of concentration)
Iodine-131	0 to 100	±10	100 or greater	±10
Barium-140	0 to 100	±10	100 or greater	±10
Cesium-137	0 to 100	±10	100 or greater	±10
Strontium-89	0 to 50	± 5	50 or greater	±10
Strontium-90	0 to 20	± 2	20 or greater	±10

[a] Two standard deviations (2σ).

Calcium analyses at SERHL are done by an ion exchange and permanganate titration method, while at NERHL and SWRHL an ethylenediaminetetraacetic acid (EDTA) method is used. Stable potassium concentrations are estimated from the potassium–40 concentrations [2] determined from the gamma spectrum.

Data presentation

Table 2 presents summaries of the analyses for February 1965 (actual reporting period is January 31-February 27, 1965). Barium–140 results are not presented because the monthly average concentrations in milk were less than 10 pCi/liter. Radionuclide values reported by a laboratory as being below the minimum detectable concentration have been averaged by using one-half the minimum detectable value. The averaging procedure was modified for iodine–131 and barium–140 in October 1963 when nondetectable concentrations of these radionuclides were considered zero. A similar procedure is used for the network average.

Figures 1 and 2 are isogram maps showing the estimated strontium–90 and cesium–137 concentrations in milk over the entire country. The value printed beside each station is the monthly average concentration for that station. The isograms were developed by arbitrary interpolation between values for the individual stations. Additional modifications to the isograms are made according to available information on milksheds.

The ranges of monthly averages for strontium–90 and cesium–137 at network stations for the last six months and February 1964 are compared in tables 3 and 4. The average

[2] The conversion factor is 1.18 x 10^{-3} g K/pCi ^{40}K.

TABLE 2.—AVERAGE CONCENTRATIONS OF STABLE ELEMENTS AND RADIONUCLIDES IN PASTEURIZED MILK, FOURTH QUARTER 1964 AND FEBRUARY 1965[a]

Sampling locations		Calcium (g/liter)		Strontium-89 (pCi/liter)		Strontium-90 (pCi/liter)		Cesium-137 (pCi/liter)		Iodine-131 (pCi/liter)	
		Fourth quarter	Avg. for month	Fourth quarter	Avg. for month	Fourth quarter	Avg. for month	Fourth quarter	Avg. for month	Fourth quarter	Avg. for month
Ala:	Montgomery	1.20	1.20	<5	<5	19	20	60	55	0	0
Alaska:	Palmer	1.22	1.21	<5	<5	19	19	80	55	0	0
Ariz:	Phoenix	1.19	1.22	<5	<5	4	11	25	30	0	0
Ark:	Little Rock	1.17	1.18	<5	<5	33	34	60	65	0	0
Calif:	Sacramento	1.26	1.28	<5	<5	5	7	25	40	0	0
	San Francisco	1.22	1.33	<5	<5	8	5	30	30	0	0
C. Z:	Cristobal	1.14	1.14	<5	<5	5	4	50	35	0	0
Colo:	Denver	1.29	1.25	<5	<5	16	20	65	70	0	0
Conn:	Hartford	1.13	1.14	<5	<5	14	15	85	90	0	0
Del:	Wilmington	1.17	1.16	<5	<5	16	18	70	75	0	0
D. C:	Washington	1.15	1.18	<5	<5	17	16	45	60	0	0
Fla:	Tampa	1.18	1.18	<5	<5	15	13	210	145	0	0
Ga:	Atlanta	1.20	1.20	<5	<5	24	24	85	90	0	0
Hawaii:	Honolulu	1.20	1.21	5	<5	13	12	70	70	0	0
Idaho:	Idaho Falls	1.23	1.16	<5	<5	19	24	80	115	0	0
Ill:	Chicago	1.16	1.12	<5	<5	16	17	75	90	0	0
Ind:	Indianapolis	1.20	1.18	<5	<5	15	18	60	80	0	0
Iowa:	Des Moines	1.22	1.22	<5	<5	21	22	55	70	0	0
Kans:	Wichita	1.26	1.20	<5	<5	17	20	40	60	0	0
Ky:	Louisville	1.18	1.18	<5	<5	23	22	45	60	0	0
La:	New Orleans	1.23	1.24	10	<5	40	44	75	70	0	0
Maine:	Portland	1.18	1.14	<5	<5	24	23	145	140	0	0
Md:	Baltimore	1.16	1.17	<5	<5	18	18	50	65	0	0
Mass:	Boston	1.15	1.18	<5	<5	22	24	125	135	0	0
Mich:	Detroit	1.17	1.17	<5	<5	15	16	75	85	10	0
	Grand Rapids	1.20	1.18	<5	<5	19	19	85	85	0	0
Minn:	Minneapolis	1.24	1.19	5	<5	24	28	80	90	0	0
Miss:	Jackson	1.23	1.26	<5	<5	32	33	60	55	0	0
Mo:	Kansas City	1.22	1.22	<5	<5	21	19	40	60	0	0
	St. Louis	1.24	1.25	<5	<5	18	19	45	50	0	0
Mont:	Helena	1.25	1.28	<5	<5	16	18	85	100	0	0
Nebr:	Omaha	1.19	1.19	<5	<5	17	20	45	50	0	0
Nev:	Las Vegas	1.24	1.07	<5	<5	8	10	50	40	0	0
N. H:	Manchester	1.18	1.16	<5	<5	23	24	155	155	0	0
N. J:	Trenton	1.12	1.12	<5	<5	15	18	70	85	0	0
N. Mex:	Albuquerque	1.23	1.22	<5	<5	9	13	45	40	0	0
N. Y:	Buffalo	1.11	1.10	<5	<5	16	17	90	110	0	0
	New York	1.15	1.12	<5	<5	19	20	95	105	0	0
	Syracuse	1.12	1.10	<5	<5	15	16	90	90	0	0
N. C:	Charlotte	1.21	1.21	<5	<5	33	27	65	65	0	0
N. Dak:	Minot	1.19	1.21	<5	<5	38	49	110	120	0	0
Ohio:	Cincinnati	1.19	1.16	<5	<5	17	16	60	70	0	0
	Cleveland	1.17	1.14	<5	<5	18	18	75	90	0	0
Okla:	Oklahoma City	1.18	1.20	5	<5	18	21	45	55	0	0
Ore:	Portland	1.29	1.27	<5	<5	22	22	90	115	0	0
Pa:	Philadelphia	1.18	1.17	<5	<5	16	18	65	80	0	0
	Pittsburgh	1.18	1.17	<5	<5	24	24	85	100	0	0
P. R:	San Juan	1.14	1.16	<5	<5	10	14	50	55	0	0
R. I:	Providence	1.17	1.16	<5	<5	18	18	95	100	0	0
S. C:	Charleston	1.17	1.20	<5	<5	29	30	90	85	0	0
S. Dak:	Rapid City	1.03	0.94	<5	<5	27	26	115	150	0	0
Tenn:	Chattanooga	1.20	1.21	5	<5	31	30	65	70	0	0
	Memphis	1.20	1.22	<5	<5	25	25	45	45	0	0
Tex:	Austin	1.14	1.16	<5	<5	7	10	25	40	0	0
	Dallas	1.18	1.17	<5	<5	15	17	35	50	0	0
Utah:	Salt Lake City	1.34	1.27	<5	<5	18	33	90	130	0	0
Vt:	Burlington	1.16	1.12	<5	<5	20	20	105	120	10	0
Va:	Norfolk	1.19	1.21	<5	<5	21	19	60	60	0	0
Wash:	Seattle	1.24	1.27	<5	<5	20	28	95	95	0	0
	Spokane	1.30	1.25	<5	<5	22	23	95	100	0	0
W. Va:	Charleston	1.16	1.19	<5	<5	17	16	40	50	0	0
Wis:	Milwaukee	1.22	1.22	<5	<5	14	14	85	100	0	0
Wyo:	Laramie	1.22	1.21	<5	<5	15	16	70	70	0	0
Network average		1.19	1.19	<5	<5	18.8	20.2	73	80	0	0

[a] Results of barium-140 analysis all zero.

monthly strontium–90 concentrations in pasteurized milk from selected cities in the sampling program are presented in figure 3. Each graph shows the strontium–90 concentrations in milk from one city in U.S. Bureau of Census regions. This method of selection permits graphic presentation of data for each city in the network three times a year.

For special purposes of comparison and reference, the Network maximum, minimum, and average monthly radionuclide concentrations for the early years of operation (March 1960-March 1964) were summarized in tabular form in the July 1964 *RHD* (*2*). An annual summary for 1964 appeared in the April 1965 *RHD* (*3*).

TABLE 3.—RANGES OF STATION MONTHLY AVERAGES FOR STRONTIUM-90, SEPTEMBER 1964–FEBRUARY 1965, AND FEBRUARY 1964

Range, pCi/liter	Number of stations in range						
	1964				1965		1964
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Feb.
Under 10	8	6	6	8	6	3	3
10–19	27	37	31	29	32	31	15
20–29	20	13	19	20	19	22	28
30–39	6	7	6	4	4	5	13
40–49	2	0	1	2	1	2	3
50–59	0	0	0	0	1	0	0
60–69	0	0	0	0	0	0	1

TABLE 4.—RANGES OF STATION MONTHLY AVERAGES FOR CESIUM-137, SEPTEMBER 1964–FEBRUARY 1965, AND FEBRUARY 1964

Range, pCi/liter	Number of stations in range						
	1964				1965		1964
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Feb.
Under 50	14	16	15	9	11	8	1
50–99	33	40	41	38	38	38	14
100–149	13	6	4	14	12	15	24
150–199	2	0	2	2	2	2	17
200–249	1	1	1	0	0	0	5
250–299	0	0	0	0	0	0	2

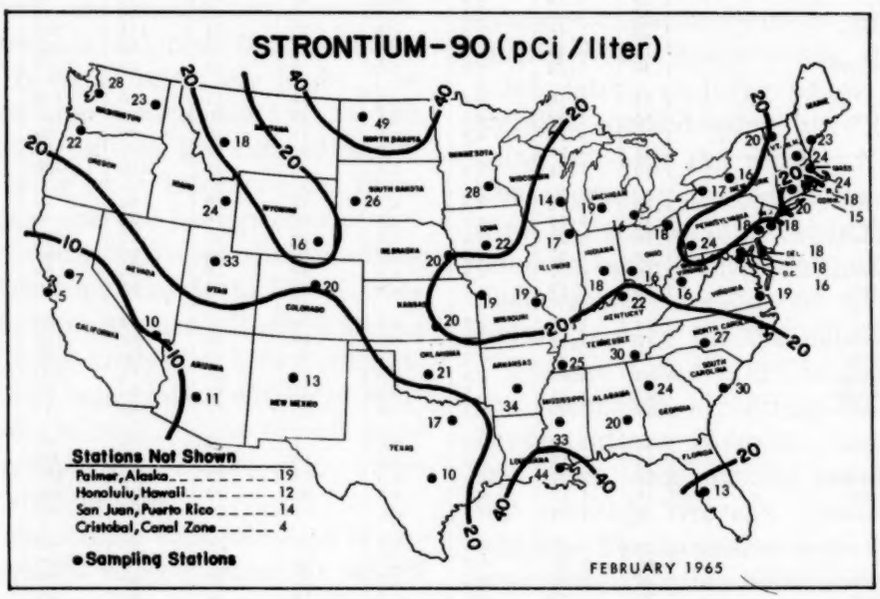

FIGURE 1.—STRONTIUM-90 CONCENTRATIONS IN PASTEURIZED MILK, FEBRUARY 1965

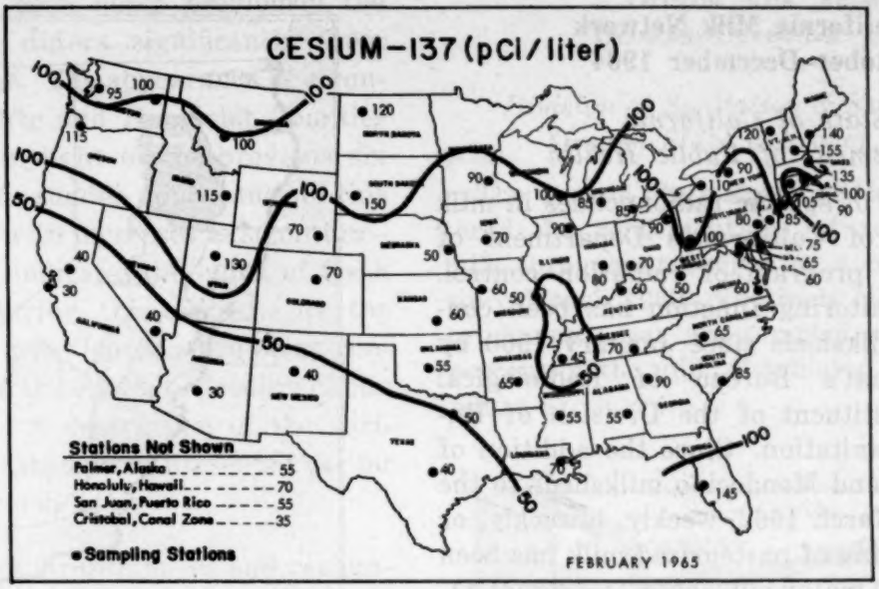

FIGURE 2.—CESIUM–137 CONCENTRATIONS IN PASTEURIZED MILK, FEBRUARY 1965

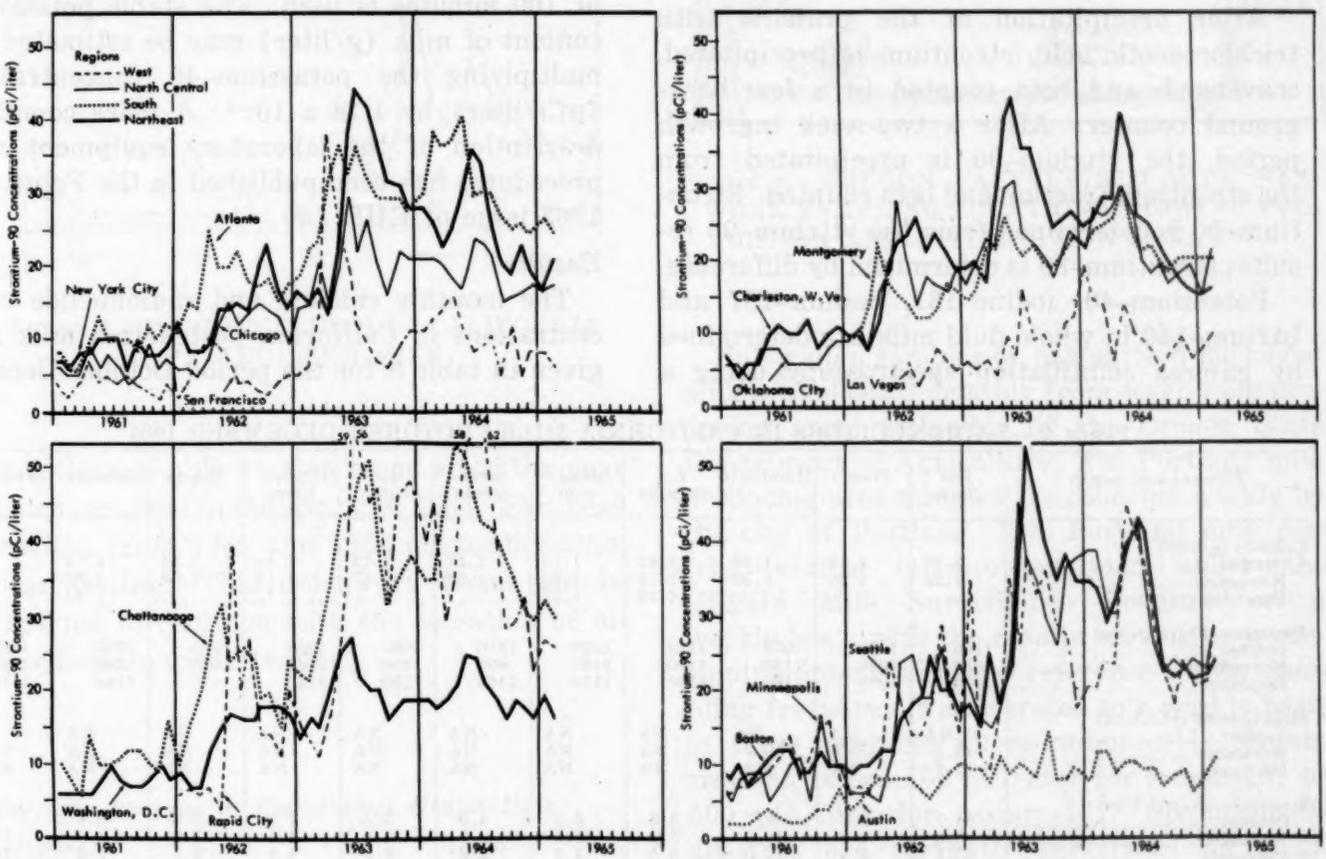

FIGURE 3.—STRONTIUM–90 IN PASTEURIZED MILK, 1961–FEBRUARY 1965

2. California Milk Network October–December 1964

State of California
Department of Public Health

Surveillance of specific radionuclides in milk is one phase of California's Department of Public Health program of radiation control. This milk monitoring function has been conducted at 8 milksheds since January 1960 by the Department's Bureau of Radiological Health, a constituent of the Division of Environmental Sanitation. Since the addition of the Del Norte and Mendocino milksheds to the programs in March 1962, weekly, biweekly, or monthly sampling of pasteurized milk has been conducted at 10 major milksheds (see figure 4). The original sampling locations were chosen by the State Department of Agriculture as being representative of milk consumed by a high percentage of the population of the State.

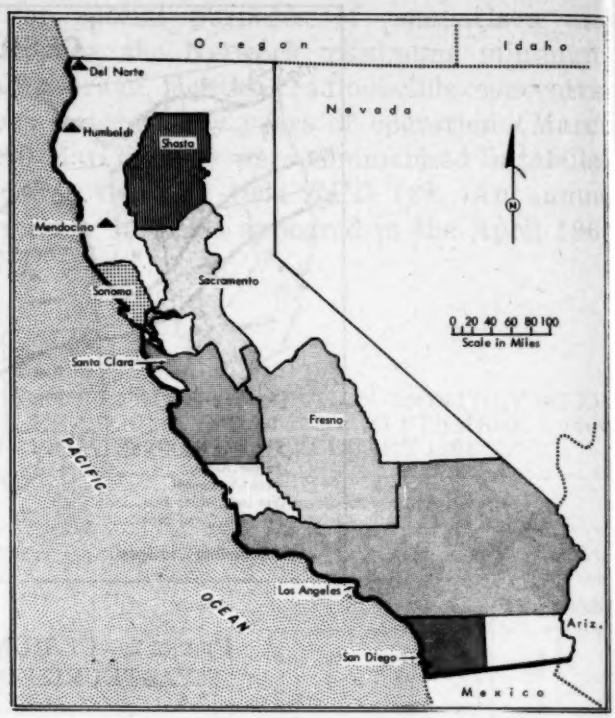

FIGURE 4.—CALIFORNIA MILKSHEDS

Analytical procedures

After precipitation of the proteins with trichloroacetic acid, strontium is precipitated, scavenged, and beta counted in a low background counter. After a two-week ingrowth period, the yttrium–90 is precipitated from the strontium fraction and beta counted. Strontium–90 is determined from the yttrium–90 results; strontium–89 is determined by difference.

Potassium–40, iodine–131, cesium–137 and barium–140 in whole fluid milk are determined by gamma scintillation spectroscopy using a sodium iodide crystal. A normal counting time of 100 minutes is used. The stable potassium content of milk (g/liter) may be estimated by multiplying the potassium–40 concentration (pCi/liter) by 1.18×10^{-3}. A more complete description of the laboratory equipment and procedures has been published in the February 1963 issue of RHD (*3*).

Results

The monthly calcium and radionuclide concentrations in California pasteurized milk are given in table 5 for the period October-Decem-

TABLE 5.—RADIONUCLIDES IN CALIFORNIA MILK,[a] OCTOBER–DECEMBER 1964

Element and month	Del Norte	Fresno	Humboldt	Los Angeles	Mendocino	Sacramento	San Diego	Santa Clara	Shasta	Sonoma	Average
Calcium (g/liter)											
October	1.28	1.18	1.20	1.07	1.10	1.12	1.13	1.10	1.14	1.15	1.15
November	1.33	1.26	1.30	1.16	1.26	1.23	1.17	1.11	1.08	1.36	1.23
December				1.29	1.27					1.19	1.25
Potassium-40 (pCi/liter)											
October	1160	1170	1070	1270	1290	1210	1080	1220	1220	1300	1199
November	1080	1080	1110	1190	1180	992	1200	1140	1170	1280	1142
December	1070	1090	1190	1160	1150	1160	1180	1140	1170	1140	1145
Strontium-89 (pCi/liter)											
October	[b] NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
November	48.5	NA	19.7	NA	NA	NA	NA	NA	NA	NA	6.8
December	53.7	NA	5.8	NA	NA	NA	NA	NA	NA	NA	6.0
Strontium-90 (pCi/liter)											
October	34.7	3.2	8.7	3.6	5.3	4.9	3.5	4.2	6.8	5.9	8.1
November	40.6	4.0	16.2	5.2	11.6	4.7	4.2	4.6	13.9	8.0	11.3
December	35.5	5.4	17.0	6.5	4.3	5.3	6.9	4.0	8.7	7.5	10.1
Cesium-137 (pCi/liter)											
October	67	23	22	12	8	25	16	17	23	7	22
November	129	34	101	37	12	53	24	36	39	42	51
December	173	39	81	38	44	33	25	31	48	36	55

[a] No significant amounts of iodine-131 or barium-lanthanum-140 in samples for this period were found.
[b] NA indicates no analysis.

ber 1964. As has been noted previously the Del Norte sample differs significantly from the network average. The appearance of strontium–89 in Del Norte and Humboldt Counties was not expected in light of the previous six months' results. The sudden appearance of this radionuclide along with increases in strontium–90 and cesium–137 indicates the influx of fresh fission products during this period. At the present time, field investigations are being conducted to determine the effects of feeding habits upon these values. A description of the various California milksheds was presented earlier by Heslep and Cornish (4).

Network average strontium–90 and cesium–137 concentrations are presented graphically in figure 5. Superimposed upon normal seasonal

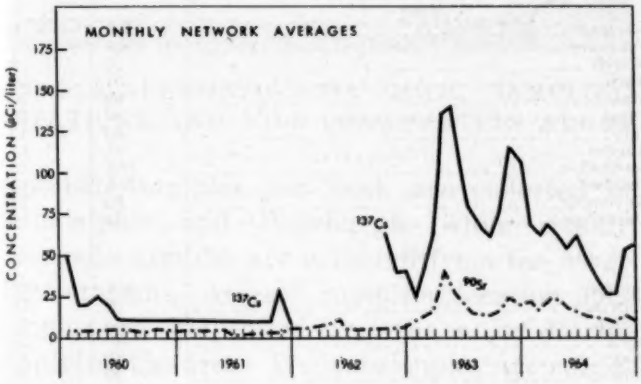

FIGURE 5.—RADIONUCLIDES IN CALIFORNIA PASTEURIZED MILK

variations is a decreasing trend since the peak which occurred in the spring of 1963. This peak resulted from 1961 and 1962 atmospheric nuclear testing. This downward trend can be expected to continue with the cessation of atmospheric nuclear testing.

Previous coverage in *Radiological Health Data:*

Period	Issue
July–September 1963	*March 1964*
October–December 1963	*June 1964*
January–March 1964	*September 1964*
April–June 1964	*December 1964*
July–September 1964	*March 1965*

3. Oregon Milk Network October–December 1964

Division of Sanitation & Engineering, Oregon State Board of Health

The Oregon State Board of Health has monitored the concentrations of radionuclides in milk throughout Oregon on a continuing basis since March 1962. Routinely eight major milk producing areas are sampled, representing 90 percent of the milk distributed in Oregon (see figure 6).

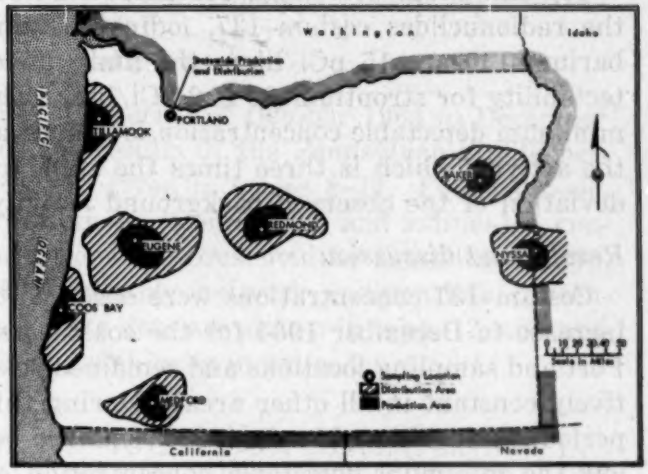

FIGURE 6.—OREGON PASTEURIZED MILK NETWORK SAMPLING LOCATIONS SHOWING PRODUCTION AND DISTRIBUTION AREAS

Half-gallon samples of pasteurized packaged milk are collected monthly from seven milk producing areas statewide by the Oregon State Department of Agriculture. The Portland milk producing area samples are collected weekly by the city of Portland. The Portland milk district sample is also analyzed under the USPHS Milk Surveillance Program on a weekly basis with the results serving as a continuing interlaboratory reference. Milk sampling frequency is accelerated to a weekly basis at those locations where radionuclide concentrations exceed 100 pCi/liter for iodine–131 or 500 pCi/liter for cesium–137. Strontium–90 analyses are currently performed on a bimonthly schedule with a monthly schedule planned when significant increases are observed.

Analytical procedures

All milk samples are forwarded to and analyzed by the Oregon State Board of Health Environmental Radiation Laboratory. The concentrations of cesium–137, iodine–131 and barium–140 are determined by gamma spectrometry using a 3 x 3-inch scintillation detector with a 512-channel analyzer-computer. Strontium–90 concentrations are determined using a trichloroacetic acid analytical procedure (*5*) with the counting performed using a low background counting system with a 2¼-inch detector.

The minimum detectable concentrations for the radionuclides cesium–137, iodine–131 and barium–140 are 15 pCi/liter; the limit of detectability for strontium–90 is 2 pCi/liter. The minimum detectable concentration is defined as the activity which is three times the standard deviation of the observed background activity.

Results and discussion

Cesium–137 concentrations were observed to increase in December 1964 for the coastal and Portland sampling locations and remained relatively constant in all other areas. During this period iodine–131 and barium–140 remained below the minimum detectable concentration of 15 pCi/liter. The October-December 1964 results appear in table 6.

TABLE 6.—RADIONUCLIDE CONCENTRATIONS IN OREGON MILK, OCTOBER-DECEMBER 1964

Sampling location	Concentrations in pCi/liter					
	Strontium-90 1964			Cesium-137 1964		
	Oct	Nov	Dec	Oct	Nov	Dec
Baker	21	36	NA	105	90	65
Coos Bay	• NA	NA	NA	90	90	225
Eugene	NA	24	NA	75	85	70
Medford	NA	13	NA	80	80	75
Nyssa	NA	20	NA	45	40	70
Portland composite	22	NA	NA	89	109	112
Portland local	NA	NA	NA	92	99	130
Redmond	NA	NA	NA	105	80	75
Tillamook	36	28	NA	115	145	160
Average	26	24		88	91	109

• NA indicates no analysis.

General trends for the levels of strontium–90 and cesium–137 can be observed from the concentrations representing the monthly network averages listed in table 7 and presented graphically in figure 7. The peak concentrations observed during the spring of 1963 have shown a continual decrease, except for seasonal variations. This general trend can be expected to continue with the cessation of atmospheric nuclear testing.

The radionuclide concentrations in Oregon milk have remained low in comparison to the recommendations of the Federal Radiation Council for remedial action based upon health implications.

TABLE 7.—AVERAGE MONTHLY RADIONUCLIDE CONCENTRATIONS IN OREGON MILK

Month and year	Radionuclides	
	Strontium-90	Cesium-137
	pCi/liter	pCi/liter
1962		
July	• NA	56
August	NA	63
September	NA	51
October	NA	83
November	NA	86
December	NA	83
1963		
January	NA	68
February	NA	71
March	13	69
April	51	142
May	89	246
June	53	223
July	83	190
August	51	157
September	NA	147
October	NA	139
November	36	174
December	26	173
1964		
January	NA	165
February	20	162
March	25	137
April	36	170
May	36	179
June	26	162
July	26	140
August	24	113
September	20	87
October	26	88
November	24	91
December	NA	109

• NA indicates no analysis.

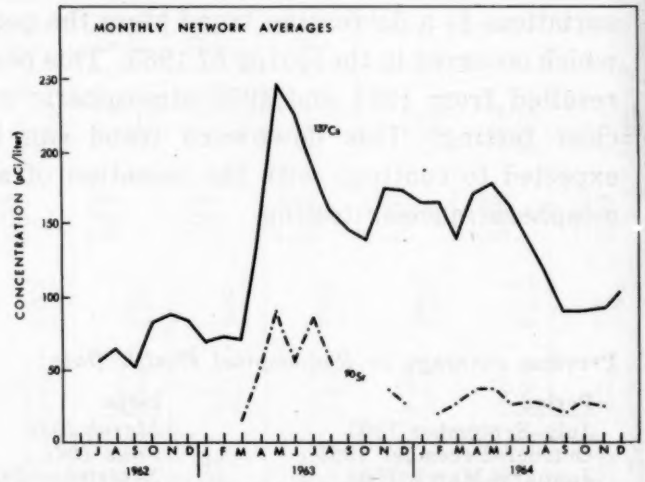

FIGURE 7.—RADIONUCLIDES IN OREGON MILK NETWORK

4. Pennsylvania Milk Network October–December 1964

Bureau of Environmental Health, Pennsylvania Department of Health

Samples of pasteurized milk are routinely collected from ten major milk consumption areas throughout Pennsylvania (figure 8). Two

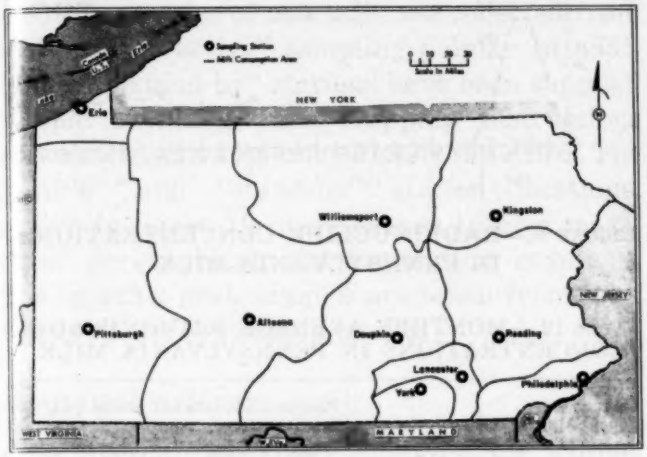

FIGURE 8.—PENNSYLVANIA MILK SAMPLING STATIONS AND MILK CONSUMPTION AREAS

composite samples per week are collected in Philadelphia and Pittsburgh, while weekly composite samples are collected from the other eight stations. At each sampling location subsamples are composited from the major dairies supplying the area. The subsamples are subsequently composited in proportion to the amount of milk processed in each dairy. This composite is then sent to the Radiation Laboratory of the Division of Occupational Health in Harrisburg where the weekly samples are combined for monthly analyses. Strontium–90 analyses have been carried out since April 1963. Iodine–131 analyses were carried out from September 1962 through January 1963, at which time concentrations fell below detectable levels. Iodine–131 analyses were resumed in October 1964 following the mainland China nuclear detonation of October 16.

Analytical procedure

The chemical separation technique for strontium–90 is essentially an ion exchange method described by Porter *et al* (*6*). One liter of milk is passed through an ion exchange column; yttrium–90 is eluted from the resin and is counted in an automatic low-background proportional counter.

Iodine–131 is also determined by an ion exchange resin technique (*7*). One liter of milk is passed through an ion exchange column. The exchange resin is subsequently counted and analyzed with a 2 x 2-inch sodium iodide crystal detector and multichannel pulse height analyzer.

Cesium–137 and potassium–40 concentrations are determined by gamma scintillation spectroscopy. The resultant gamma spectra are processed using a matrix system of analysis.

Results and discussion

For the period of October 1964 to December 1964 the results of the Pennsylvania milk network are given in tables 8–11. Potassium–40, strontium–90, cesium–137, and iodine–131 concentrations are presented by sampling station.

The monthly network radionuclide concentrations to date are shown in table 12, and presented graphically in figure 9.

TABLE 8.—POTASSIUM-40 CONCENTRATIONS IN PENNSYLVANIA MILK, OCTOBER–DECEMBER 1964

Sampling location	Potassium-40, pCi/liter		
	October	November	December
Altoona	[a] NA	1047	1033
Dauphin	1103	1014	1166
Erie	NA	1252	936
Kingston	NA	983	958
Lancaster	970	972	964
Philadelphia	NA	1023	1073
Pittsburgh	1048	1032	1092
Reading	1011	1022	1112
Williamsport	NA	1162	984
York	1031	1123	1096
State average	1033	1068	1041

[a] NA indicates no analysis performed.

TABLE 9.—STRONTIUM-90 CONCENTRATIONS IN PENNSYLVANIA MILK, OCTOBER–DECEMBER 1964

Sampling location	Strontium-90, pCi/liter		
	October	November	December
Altoona	20	17	34
Dauphin	24	24	16
Erie	23	29	21
Kingston	16	26	21
Lancaster	12	14	23
Philadelphia	17	25	28
Pittsburgh	28	27	27
Reading	14	18	30
Williamsport	19	16	20
York	12	14	20
State average	18.5	21.0	24.0

TABLE 10.—CESIUM-137 CONCENTRATIONS IN PENNSYLVANIA MILK, OCTOBER–DECEMBER 1964

Sampling location	Cesium-137, pCi/liter		
	October	November	December
Altoona	* NA	81	110
Dauphin	88	90	106
Erie	NA	113	117
Kingston	NA	111	115
Lancaster	76	70	89
Philadelphia	NA	95	94
Pittsburgh	73	96	120
Reading	101	77	120
Williamsport	NA	102	101
York	88	81	93
State average	85	92	107

* NA indicates no analysis performed.

TABLE 11.—IODINE-131 CONCENTRATIONS IN PENNSYLVANIA MILK, OCTOBER–DECEMBER 1964

Sampling location	Iodine-131, pCi/liter		
	October	November	December
Altoona	* NA	29	14
Dauphin	19	18	18
Erie	NA	23	16
Kingston	NA	13	15
Lancaster	54	16	10
Philadelphia	NA	10	10
Pittsburgh	<10	34	11
Reading	47	10	10
Williamsport	NA	27	30
York	<10	11	<10
State average	28	19	14

* NA indicates no analysis performed.

The expected seasonal variations are noted to reflect a decreasing trend since the atmospheric nuclear test ban treaty. An increase is noted as a result of the Chinese nuclear detonation of October 16, 1964, during the latter part of 1964. In the spring the iodine–131 concentration can be expected to decrease, accompanied by normal seasonal variation in strontium–90 and cesium–137 concentrations. The observed radionuclide concentrations can be compared with the Federal Radiation Council guides for peacetime operation indicating that at no time during 1964 did the radionuclide concentrations in Pennsylvania milk reach levels such that remedial actions were suggested on the basis of health implications.

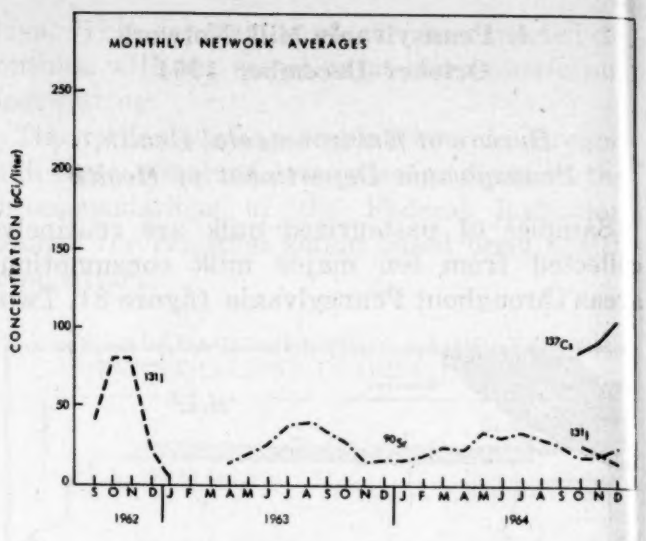

FIGURE 9.—RADIONUCLIDE CONCENTRATIONS IN PENNSYLVANIA MILK

TABLE 12.—MONTHLY AVERAGE RADIONUCLIDE CONCENTRATIONS IN PENNSYLVANIA MILK

Month and year	Radionuclide concentrations, pCi/liter			
	^{40}K	^{90}Sr	^{137}Cs	^{131}I
1962				
September	* NA	NA	NA	41.2
October	NA	NA	NA	80
November	NA	NA	NA	80.6
December	NA	NA	NA	24.4
1963				
January	NA	NA	NA	<10
February	NA	NA	NA	NA
March	NA	NA	NA	NA
April	NA	13.5	NA	NA
May	NA	19.7	NA	NA
June	NA	25.1	NA	NA
July	NA	35.5	NA	NA
August	NA	38.6	NA	NA
September	NA	32.0	NA	NA
October	NA	25.4	NA	NA
November	NA	14.7	NA	NA
December	NA	16.7	NA	NA
1964				
January	NA	15.5	NA	NA
February	NA	18.5	NA	NA
March	1563	22.6	137	NA
April	NA	18.9	NA	NA
May	NA	33.9	NA	NA
June	NA	29.8	NA	NA
July	NA	32.6	NA	NA
August	NA	28.5	NA	NA
September	NA	25.0	NA	NA
October	1033	18.5	85	28
November	1068	21.0	92	19
December	1041	24.0	107	14

* NA indicates no analysis performed.

Previous coverage in *Radiological Health Data:*

Period	Issue
September 1962–November 1963	*March 1964*
December 1963–March 1964	*July 1964*
April–June 1964	*October 1964*
August–September 1964	*February 1965*

5. Texas Milk Network April–December 1964

Texas State Department of Health

The Texas State Department of Health initiated a Statewide milk sampling network for radionuclide content in April 1964. At present, monthly samples of raw milk are collected from each of six "active" sampling points. In addition, six "stand-by" stations have been supplied sample containers and shipping instructions and can be activated immediately if needed. The "active" and "stand-by" station locations, shown in figure 10, were chosen to give maximum geographical and population coverage. The monthly grab samples are taken from tank trucks at the processing plants.

FIGURE 10.—TEXAS MILK SAMPLING STATIONS

Analytical methods

Samples are routinely analyzed for iodine–131, barium–140, cesium–137, potassium–40, strontium–89, and strontium–90. The gamma-emitting radionuclides are analyzed using a 4 x 4-inch sodium iodide crystal and a 400-channel analyzer. Samples are counted for 100 minutes in a 3½-liter Marinelli beaker. The matrix method of calculation is used and detectable limits at the 95 percent confidence level are 10 pCi/liter. Calcium determinations are not made.

TABLE 13.—RADIONUCLIDE CONCENTRATIONS IN TEXAS MILK NETWORK, APRIL TO DECEMBER 1964

Sampling location	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
	Potassium-40 (pCi/liter)								
Austin	1260	1230	1250	1290	NA	1180	1280	1320	1340
Dallas	* NA	NA	NA	1280	1330	1290	1270	1270	1310
El Paso	1255	1270	1230	1285	1250	1290	1260	1340	1360
Harlingen	1255	1320	1270	1320	1230	1190	1280	1360	1410
Houston	1255	1320	1290	1320	1280	1300	1300	1380	1380
Lubbock	1240	1265	1215	1245	1230	1260	1210	1330	1350
Average	1253	1280	1251	1290	1264	1252	1267	1333	1358
	Strontium-90 (pCi/liter)								
Austin	10	10	9	11	NA	7	6	7	8
Dallas	* NA	NA	NA	10	NA	NA	10	8	8
El Paso	12	5	5	8	6	4	3	4	5
Harlingen	10	9	8	6	6	10	4	5	5
Houston	17	22	19	16	13	14	14	10	11
Lubbock	8	12	10	11	6	7	6	7	5
Average	11	12	10	9	8	10	7	7	7
	Cesium-137 (pCi/liter)								
Austin	35	40	40	55	NA	35	30	15	25
Dallas	* NA	NA	NA	35	30	35	20	30	30
El Paso	35	20	25	25	30	25	15	15	25
Harlingen	30	25	25	30	20	25	25	20	20
Houston	90	80	65	65	55	45	35	40	50
Lubbock	30	35	30	30	30	20	20	20	30
Average	44	40	30	40	33	31	24	23	30

* NA—No analysis performed.

Strontium–89 and strontium–90 are analyzed by the chemical separation technique using ion exchange columns (*6*). Prepared samples are counted for 100 minutes in a low-background beta counter.

Results

The results of the Texas Milk Network for the period April to December 1964 are presented in table 13. Potassium–40, strontium–90, and cesium–137 concentrations are given by station and month. During this time, the strontium–89 concentration was below the limit of detectability (5 pCi/liter). Iodine–131 and barium–140 were also below their limits of detectability (10 pCi/liter).

Network average concentrations are shown graphically in figure 11. Comparison of the observed radionuclide concentrations with the Federal Radiation Council guides for peacetime operation indicates that at no time during the period of surveillance did the radionuclide concentrations in Texas milk approach such levels that remedial action was suggested based on health implications.

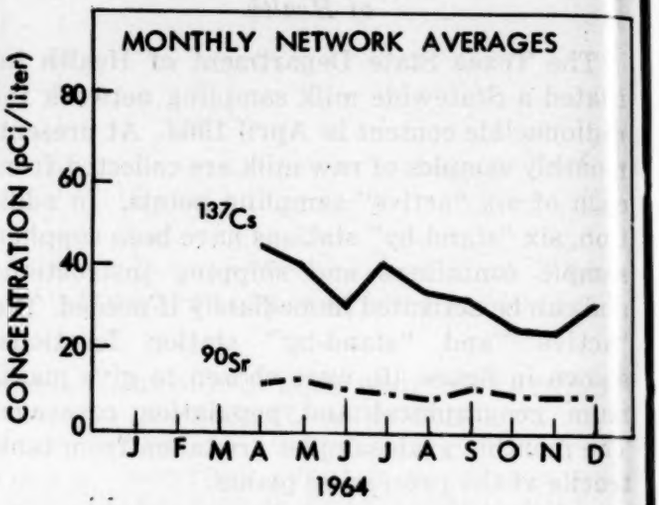

FIGURE 11.—RADIONUCLIDE CONCENTRATIONS IN TEXAS MILK NETWORK

6. Canadian Milk Network[3] February 1965

Radiation Protection Division, Department of National Health and Welfare, Ottawa, Canada

The Radiation Protection Division of the Department of National Health and Welfare began monitoring milk for strontium–90 in November 1955. At first, analyses were carried out on samples of powdered milk obtained from processing plants. However, since January 1963 liquid whole milk has been analyzed instead. With this change, more representative samples of milk consumed can be obtained, and in addition it is possible to choose milk sampling locations (see figure 12) in the same areas as the air and precipitation stations. At present, the analyses include determinations of iodine–131, strontium–89, cesium–137, and strontium–90 as well as stable potassium and calcium.

The milk samples are obtained through the cooperation of the Marketing Division of the Canadian Department of Agriculture. At each station samples are collected three times a week from selected dairies and are combined into weekly composites and forwarded to the radiochemical laboratory in Ottawa. The contribution of each dairy to the composite sample is directly proportional to its volume of sales. In most cases a complete sample represents over 80 percent of the milk processed and distributed in the area. Several of the weekly samples are randomly selected and analyzed for iodine–131. The results of the spot checks for iodine–131 will not be reported unless there is evidence that the levels are rising. A monthly composite of the samples is analyzed for strontium–90, cesium–137, and stable potassium and calcium.

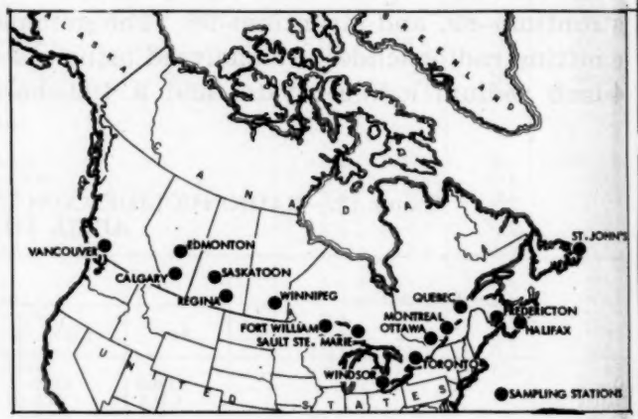

FIGURE 12.—CANADIAN MILK SAMPLING STATIONS

[3] Data from *Radiation Protection Programs*, Vol. 3, No. 3: 25–30. Radiation Protection Division, Canadian Department of National Health and Welfare (March 1965).

Analytical methods

Radiochemical methods are used for the analysis of iodine–131 (*8*). For the analysis of radiostrontium, carrier strontium is added to a one-liter sample of milk, and the milk is then placed in a tray lined with a polyethylene sheet and evaporated under infrared lamps. The residue is ashed in a muffle furnace at 450 degrees C., dissolved in dilute nitric acid, and strontium separated by fuming nitric acid precipitation. The combined strontium–89 and strontium–90 are determined by counting in a low-background beta counter. Strontium–90 is determined separately by extracting and counting its yttrium–90 daughter, while strontium–89 is estimated by difference from the total radiostrontium measurement. Appropriate corrections are made for self-absorption and counter efficiency at all stages. Calcium is determined by flame photometry.

Cesium–137 is determined by gamma spectroscopy using a scintillation crystal and a multi-channel pulse-height analyzer. A sample consisting of 4.5 liters of milk is placed in a sample tray constructed in the form of an inverted well to accommodate the 5 x 4-inch sodium-iodide crystal detector. The sample is counted for 100 minutes and the gamma spectrum recorded. Estimates are made of the potassium–40 and cesium–137 content of the milk by comparison of the spectrum with the spectra of standard preparations of these two radionuclides. With this method the potassium–40 concentration is determined and the Compton contribution of this radionuclide to the cesium–137 photopeak is subtracted to obtain the cesium–137 concentration. The stable potassium content is estimated from the potassium–40 concentration.

Sources of error

In the iodine and strontium determinations, tests indicate that the statistical error (95-percent confidence level) in the chemical operations involved is about plus-or-minus 10 percent. This value is independent of the concentration of the radioisotope in the milk because it depends only on the recovery of the carrier. In the determination of cesium–137 this factor is not involved.

The chemical procedures error must be combined with the counting error which depends primarily on the concentration of the nuclide in the sample, the background radiation, and the length of time the sample and background are counted. This counting error has been evaluated mathematically for the particular counting arrangement used.

The overall errors, estimated on the basis indicated above, are given in table 14.

TABLE 14.—TOTAL ERROR FOR VARIOUS RADIONUCLIDE CONCENTRATIONS IN MILK[a]

Nuclide	Error for 10 pCi/liter	Error for 50 pCi/liter	Error for 100 pCi/liter
Strontium-89	±25%	±20%	±15%
Strontium-90	±15%	±10%	±10%
Iodine-131	±50%	±20%	±10%
Cesium-137	±60%	±20%	±10%

[a] All errors are 2σ values, representing 95 confidence levels.

Results

Table 15 presents February levels of strontium–90, cesium–137, and stable calcium and potassium in Canadian whole milk. Spot checks for iodine–131 and strontium–89 indicate that all samples had insignificant levels of these radionuclides.

The results show that radionuclide concentrations in Canadian whole milk remained well below the levels permissible on health grounds.

TABLE 15.—NUCLIDES IN CANADIAN WHOLE MILK, FEBRUARY 1965

Station	Calcium (g/liter)	Potassium (g/liter)	Strontium-90 (pCi/liter)	Cesium-137 (pCi/liter)
Calgary	1.13	1.6	26.8	120
Edmonton	1.13	1.6	24.8	132
Ft. William	[a]	1.6	41.3	181
Fredericton	1.13	1.6	35.4	194
Halifax	1.08	1.6	41.4	252
Montreal	1.06	1.6	28.5	157
Ottawa	1.08	1.6	23.0	122
Quebec	1.08	1.7	39.4	228
Regina	1.08	1.7	33.2	157
St. John's, Nfld	1.00	1.5	30.8	176
Saskatoon	1.10	1.6	28.7	111
Sault Ste. Marie	1.00	1.7	32.5	193
Toronto	1.06	1.6	13.5	93
Vancouver	1.15	1.6	39.4	265
Windsor	1.10	1.6	16.3	90
Winnipeg	1.01	1.6	29.5	152
Average	1.08	1.6	30.3	164

[a] No analysis reported.

7. Pan American Milk Sampling Program February 1965

Pan American Health Organization and *Public Health Service*

In accordance with a joint agreement, the PAHO (Pan American Health Organization) and the PHS (Public Health Service), developed a collaborative program for furnishing assistance to health authorities in the Americas engaged in developing programs in radiological health.

Under this agreement, the PHS Division of Radiological Health furnishes to PAHO, on a loan basis, limited quantities of essential items of equipment and the requisite laboratory services to establish a surveillance program.

Sampling procedure

Initially, air sampling stations were established in Chile, Jamaica, Peru, and Venezuela. In August 1963 this was expanded to include a milk sampling station in Caracas, Venezuela. Between April 1964 and August 1964, milk stations were added in Jamaica at Kingston, Montego Bay, and Mandeville. Sampling varies according to local procedures.

Under the direction of the Venezuelan Institute for Scientific Investigation, weekly samples are collected, preserved with formaldehyde and composited monthly.

Jamaica, under the direction of the Ministry of Health, collects one monthly composite on a rotating basis from one of the three principal milk areas; Montego Bay (Montpelier), Mandeville, and Kingston (Spanish Town). To reduce spoilage it was necessary to establish cooling stations in the western parishes where the milk is received prior to shipping to the Condensery in Kingston. All samples are sent to the PHS Southeastern Radiological Health Laboratory for analyses.

Analytical procedures

Iodine–131 and cesium–137 are determined by gamma scintillation spectroscopy. Strontium–89, strontium–90, and barium–140 are determined radiochemically. Analytical errors are described in the *Analytical Procedures* discussion of article 1, "Pasteurized Milk Network".

Data presentation

Table 16 presents stable calcium and potassium, strontium–89, strontium–90, and cesium–137 monthly average concentrations. The monthly average of iodine–131 and barium–140 concentrations in milk were less than 10 pCi/liter. For comparison purposes, the radionuclide concentrations at Cristobal, Canal Zone, and San Juan, Puerto Rico are presented.

TABLE 16.—STABLE ELEMENT AND RADIONUCLIDE CONCENTRATIONS IN MILK, PAHO, FEBRUARY 1965

Sampling stations	Calcium (g/liter)	Potassium (g/liter)	Strontium-89 (pCi/liter)	Strontium-90 (pCi/liter)	Cesium-137 (pCi/liter)
Canal Zone:					
Cristobal	1.14	1.6	<5	4	35
Jamaica:					
Kingston	* NS	NS	NS	NS	NS
Mandeville	NS	NS	NS	NS	NS
Montego Bay	1.24	1.32	<5	20	485
Puerto Rico:					
San Juan	1.16	1.5	<5	14	55
Venezuela:					
Caracas	1.17	1.34	<5	10	25

* NS indicates no sample collected during this period.

8. Radiostrontium in Milk[4] January–December 1964

Health and Safety Laboratory
U.S. Atomic Energy Commission

In 1954 the Health and Safety Laboratory began strontium–90 monitoring of liquid whole milk in New York City to estimate the dietary contribution from ingestion of radiostrontium in milk. Subsequently, powdered milk monitoring was initiated at Perry, New York (1954) and at Mandan, North Dakota (1955). Liquid whole milk monitoring was started in Honolulu, Hawaii, in August 1959.

The New York City sample is a monthly composite of pasteurized milk purchased daily in quart containers at retail stores. Five large dairies are represented in the sample. The Honolulu samples are monthly composites of quart samples of pasteurized milk collected weekly. Samples from two dairies are analyzed and the results are averaged. The Mandan and Perry samples are monthly composites of powdered milk collected in 5-pound lots from plants in each city. The Mandan sample is powdered buttermilk used in cattle feeds. Because of its protein and fat content, this buttermilk powder is used primarily as a milk replacer or feed supplement for calves. The Perry sample is powdered whole milk used for human consumption. The source of the Honolulu milk is a herd on the island of Oahu where the cows are on pasture throughout the year.

The calcium and strontium–90 data are presented in tables 17–19. The fluctuations of strontium–90 with time are shown in figures 13 and 14.

[4] Data summarized from Health and Safety Laboratory, AEC, Fallout Program Quarterly Summary Report, HASL–155: 199–207, Office of Technical Services, Department of Commerce, Washington, D.C. 20230 (January 1, 1965).

Discussion

The increase in strontium–90 concentrations in liquid whole milk noted in 1963 was followed by a decreasing trend throughout 1964. A seasonal variation with the traditional spring peak in strontium–90 concentration was observed. The Honolulu, Hawaii, concentrations continued to remain below those of the other sampling stations.

TABLE 17. STRONTIUM-90 AND CALCIUM IN LIQUID MILK, JANUARY–DECEMBER 1964

Sampling station and month	Calcium concentration (g/liter)	Strontium-90 concentration (pCi/liter)	Strontium-90/ calcium ratio (pCi/g Ca)
New York City			
1964			
January	1.04	22.0	21.1
February	1.08	25.8	23.9
March	1.03	28.1	27.2
April	1.03	26.9	26.1
May	1.04	31.9	30.8
June	1.00	30.9	30.9
July	0.99	21.8	22.0
August	0.96	23.9	24.9
September	1.04	17.8	17.1
October	1.04	15.4	14.8
November	1.04	20.4	19.7
December	1.04	20.1	19.3
Honolulu, Hawaii			
1964			
January	1.09	8.5	7.8
February	1.15	9.4	8.2
March	1.10	11.8	10.7
April	1.08	10.5	9.8
May	1.06	10.8	10.3
June	1.08	12.0	11.2
July	1.05	10.2	9.7
August	1.02	6.8	6.6
September	1.04	7.7	7.4
October	1.05	7.2	6.8
November	1.03	8.0	7.8
December	1.04	8.0	7.6

TABLE 18.—STRONTIUM-90 AND CALCIUM IN POWDERED MILK, JANUARY–DECEMBER 1964

Sampling station and month	Calcium concentration (g/kg)	Strontium-90 concentration (pCi/kg)	Strontium-90/ calcium ratio (pCi/g Ca)
Perry, New York			
1964			
January	8.63	174	20.1
February	8.78	191	21.7
March	9.29	194	20.9
April	8.69	183	21.0
May	8.84	171	19.3
June	8.67	210	24.2
July	8.67	243	28.0
August	8.63	191	22.1
September	8.67	163	18.8
October	8.92	143	16.0
November	8.54	126	14.7
December	8.80	159	18.0

TABLE 19.—STRONTIUM-90 AND CALCIUM IN POWDERED BUTTERMILK, JANUARY–DECEMBER 1964

Sampling station and month	Calcium concentration (g/kg)	Strontium-90 concentration (pCi/kg)	Strontium-90/calcium ratio (pCi/g Ca)
Mandan, North Dakota			
1964			
January	10.8	738	68.3
February	10.6	863	81.8
March	11.3	830	73.2
April	11.5	936	81.2
May	12.1	1207	100.0
June	12.5	844	67.5
July	12.6	564	44.8
August	11.8	411	34.8
September	12.0	494	41.0
October	14.9	748	50.0
November	11.5	610	53.0
December	10.6	602	56.8

The powdered milk and buttermilk samples also displayed a downward trend in strontium–90 concentration since the 1963 peak which followed 1961 and 1962 atmospheric nuclear testing.

It is interesting to note that approximately 0.1 kg of powdered milk is used to prepare 1 liter of liquid milk. If this value is used, strontium–90 concentrations in powdered milk are comparable to those in liquid whole milk.

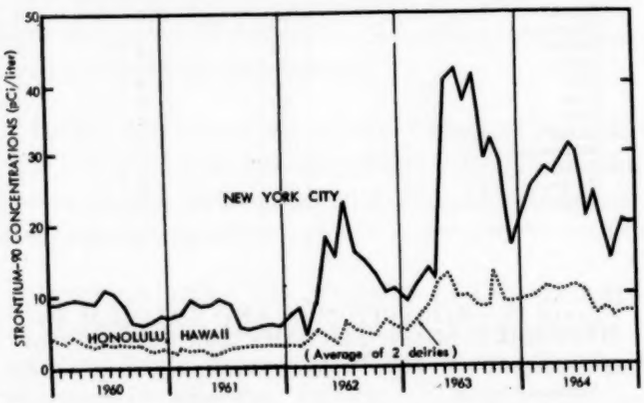

FIGURE 13.—STRONTIUM-90 IN LIQUID MILK SAMPLES

Recent coverage in *Radiological Health Data:*

Period	Issue
October 1962–March 1963	*October 1963*
April–June 1963	*January 1964*
July–September 1963	*April 1964*
October–December 1963	*July 1964*

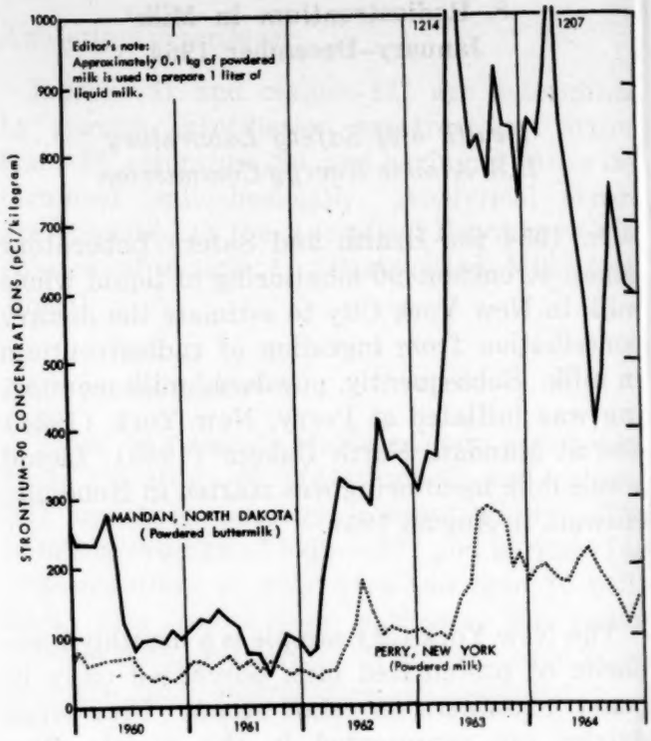

FIGURE 14.—STRONTIUM–90 IN POWDERED MILK SAMPLES

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APPLICATION OF RADIONUCLIDE CONCENTRATIONS IN MILK TO INTAKE GUIDES, MARCH 1964–FEBRUARY 1965

Division of Radiological Health, Public Health Service

The concentrations of specific radionuclides in milk analyzed as part of the Pasteurized Milk Network (PMN) are reported on a monthly basis in *RHD*. In terms of radiological health surveillance activities, an important aspect of these data is the estimation of resultant radiation dose to population groups.

Approximate relationships between certain radionuclide intakes and dose have been applied to the formulation of daily intake guides (*1*) and permissible concentrations in selected environmental media (*2*). Although these guides are not themselves directly applicable to worldwide fallout, a comparison with environmental contamination levels does yield a measure of population dosage. In general, intake-dose and dose-biological effect relationships used in formulating the guides cited are based on continuous intake over an entire lifetime. However, for general surveillance purposes, yearly average intakes, used with discretion, may be compared directly with the levels adopted as lifetime intake guides. Thus, the radionuclide concentrations in milk, averaged over a year's time, together with milk consumption data, might be used in conjunction with the references cited above to approximate the radiation dose to a specific population group from a specific radionuclide. Table 1 presents annual averages of radionuclide concentrations in milk sampled by the *PMN*. Limited data are available for estimating the average daily milk consumption (on a volume basis) for specific age groups in the U.S. population (*3*, *4*).

Total dietary intake is of prime interest, and since the intake via milk consumption constitutes only a portion of the total radionuclide intake, the relationship of milk intake to total dietary intake is of importance in evaluating milk surveillance data. The Federal Radiation Council (*5*) notes: "A number of studies have shown that conservative estimates of the strontium–90 to calcium ratio in the total diet may be made by multiplying the ratio of strontium–90 to calcium in milk in a particular locality by 1.5."[1] Thus, a rough index of the total dietary intake of strontium–90 on an annual basis may be made from PMN annual averages by using this factor and the assumptions of approximately 1.2 g of calcium per liter in PMN samples and 1.0 g daily intake of calcium.

In the case of iodine–131, milk can be considered the major source because of the rapid distribution and consumption of fresh milk. With most other foods, normal processing and distribution allows time for the radioactive decay of this short-lived nuclide to insignificant levels.

The situation with respect to strontium–89 is more complicated. Its half-life of some 50 days makes it difficult to estimate the relative contribution made by sources other than milk to the total dietary intake.

The relative contribution of milk to the total dietary intake of cesium–137 is not well defined and depends principally on the amount of freshly deposited cesium–137 on products used for human and animal consumption, and the progress of cesium–137 through the food chain.

The data in table 1 are calculated as follows: results from all samples collected in each week (Sunday through Saturday) are averaged, and

[1] This ratio may vary from 1 to 2, depending on changes in rate of fallout deposition and relative consumption of non-milk products whose contamination reflect temporal and local deposition patterns (*6*).

TABLE 1.—AVERAGE RADIONUCLIDE CONCENTRATIONS IN MILK, FOR THE TWELVE MONTH PERIODS FEBRUARY 1964–JANUARY 1965[a] AND MARCH 1964–FEBRUARY 1965[b]

Sampling locations		Average radionuclide concentrations, pCi/liter							
		Strontium-89		Strontium-90		Iodine-131		Cesium-137	
		Feb 1964–Jan 1965	Mar 1964–Feb 1965	Feb 1964–Jan 1965	Mar 1964–Feb 1965	Feb 1964–Jan 1965	Mar 1964–Feb 1965	Feb 1964–Jan 1965	Mar 1964–Feb 1965
Ala:	Montgomery	3	3	22	22	0	0	76	71
Alaska:	Palmer	5	4	20	20	0	0	115	105
Ariz:	Phoenix	3	3	4	5	0	0	25	26
Ark:	Little Rock	3	3	43	42	1	1	110	101
Calif:	Sacramento	3	3	7	7	0	0	40	38
	San Francisco	3	3	10	9	0	0	44	40
C. Z:	Cristobal	3	3	5	5	0	0	50	49
Colo:	Denver	3	3	19	19	0	0	85	83
Conn:	Hartford	3	3	19	19	0	0	127	120
Del:	Wilmington	3	3	22	22	1	1	108	101
D. C:	Washington	3	3	19	19	0	0	75	71
Fla:	Tampa	3	3	15	15	0	0	229	227
Ga:	Atlanta	3	3	31	29	0	0	125	119
Hawaii:	Honolulu	3	3	12	12	0	0	76	76
Idaho:	Idaho Falls	4	4	25	24	0	0	146	135
Ill:	Chicago	3	3	18	18	0	0	104	99
Ind:	Indianapolis	3	3	19	19	1	1	87	83
Iowa:	Des Moines	4	4	24	24	0	0	78	75
Kans:	Wichita	4	4	20	20	0	0	60	58
Ky:	Louisville	3	3	29	28	0	0	76	70
La:	New Orleans	3	3	49	49	0	0	127	120
Maine:	Portland	3	3	28	28	1	1	179	173
Md:	Baltimore	3	3	22	22	0	0	86	81
Mass:	Boston	3	3	30	29	0	0	192	182
Mich:	Detroit	3	3	18	17	2	2	100	96
	Grand Rapids	3	3	20	20	1	1	112	107
Minn:	Minneapolis	6	6	30	29	0	0	127	118
Miss:	Jackson	4	3	40	40	0	0	93	87
Mo:	Kansas City	5	4	26	25	0	0	69	66
	St. Louis	4	4	22	21	0	0	70	66
Mont:	Helena	4	4	24	22	1	1	145	133
Nebr:	Omaha	3	3	24	24	0	0	82	77
Nev:	Las Vegas	3	3	9	9	1	1	66	62
N. H:	Manchester	3	3	29	28	1	1	209	200
N. J:	Trenton	3	3	18	18	1	1	104	99
N. Mex:	Albuquerque	3	3	11	11	1	1	52	50
N. Y:	Buffalo	3	3	19	19	0	0	126	120
	New York	3	3	24	23	1	1	139	132
	Syracuse	[c] 3	[d] 3	[c] 18	[d] 18	[c] 0	[d] 0	[c] 122	115
N. C:	Charlotte	3	3	36	36	0	0	101	97
N. Dak:	Minot	10	10	53	52	0	0	144	140
Ohio:	Cincinnati	3	3	21	21	0	0	82	76
	Cleveland	3	3	20	20	0	0	103	100
Okla:	Oklahoma City	3	3	22	21	0	0	62	59
Ore:	Portland	5	5	29	28	0	0	141	139
Pa:	Philadelphia	3	3	19	19	0	0	103	98
	Pittsburgh	3	3	28	28	0	0	133	127
P. R:	San Juan	3	3	12	12	0	0	70	69
R. I:	Providence	3	3	23	22	0	0	143	136
S. C:	Charleston	3	3	32	31	0	0	119	113
S. Dak:	Rapid City	5	5	38	37	0	0	138	135
Tenn:	Chattanooga	4	3	40	39	0	0	105	98
	Memphis	3	3	32	31	0	0	64	61
Tex:	Austin	3	3	9	8	0	0	37	35
	Dallas	3	3	19	19	0	0	55	51
Utah:	Salt Lake City	6	5	24	24	0	0	159	152
Vt:	Burlington	3	3	25	24	2	2	154	147
Va:	Norfolk	3	3	18	18	0	0	85	81
Wash:	Seattle	6	6	26	27	0	0	140	139
	Spokane	5	5	26	25	0	0	128	124
W. Va:	Charleston	3	3	25	24	0	0	68	63
Wis:	Milwaukee	3	3	17	16	1	1	115	110
Wyo:	Laramie	6	6	20	19	0	0	97	95
Network average		4	3	23.1	22.7	0	0	104	100

[a] Annual averages were computed on basis of 53 weekly averages. Annual averages for barium-140 at each station were <10.
[b] Anndal averages were computed on basis of 52 weekly averages.
[c] Annual averages were computed on basis of 49 weekly averages. No sample was collected during July 1964.
[d] Annual averages were computed on basis of 48 weekly averages. No sample was collected during July 1964.

the averages for all weeks terminating in each of twelve consecutive months are averaged to obtain the annual average [2]. To obtain the annual average daily intake (pCi/day) of radionuclides from milk, the annual average concentration values (pCi/liter) in table 1 must be multiplied by the annual average daily consumption (liters/day) of milk.

Monthly variations of radionuclide concentrations in milk are influenced by a number of combined causes such as meteorologic conditions and dairying practices, apart from considerations of original sources of radionuclides. The moving yearly average (table 1) obtained by updating the previous twelve-month average by one month, shows variations averaged over the year and tends to minimize purely seasonal variations.

[2] Beginning with the October 1963 data, iodine–131 values of <10 pCi/liter have been considered zero for averaging purposes; previously, 5 pCi/liter was used for calculating the averages.

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STRONTIUM-90 IN TRI-CITY DIETS,[1] AUGUST–OCTOBER 1964

Health and Safety Laboratory,
Atomic Energy Commission

Since March 1960, the Health and Safety Laboratory, through its quarterly diet study, has made estimates of the strontium–90 content of the average diet of individuals living in New York City, San Francisco, and Chicago.

Selected foods representing 19 food categories are purchased at each of these three cities about every 3 months and are analyzed for strontium–90. Using data from the U.S. Department of Agriculture (*1*) the annual consumption by an average individual can be grouped into the same 19 food categories. The annual dietary intake of strontium–90 can be estimated by summing the contributions from each category. Some food types are assumed to be representative of larger food categories, such as liquid milk for dairy products in general.

The consumption data (*1*) are based on a weight-as-purchased basis. Before the food samples for the Tri-City Diet Study are ashed for radiochemical analysis, they are prepared to a certain degree as if for actual consumption. For example, fruits are peeled, eggs are shelled, and poultry is boned. Therefore, concentrations of radioactivity in foods as reported in the Tri-City Diet Study are based on the trimmed weight. No correction is made for the waste.

After two samplings at each city it was found that the calcium content of most food categories did not vary among cities, nor did it vary significantly with time. Calcium analyses of dietary components were performed for the third time recently, and further confirmed this result (*2*). Calcium analyses were therefore discontinued and average calcium content of foods was computed and used to estimate the average annual intake of this mineral. Details of the sampling system and a discussion of the results obtained have been summarized (*3*).

[1] Data from *Fallout Program Quarterly Summary Report, HASL–155*:208–10, Office of Technical Services, Department of Commerce, Washington, D. C. 20230 (January 1, 1965) price $4.00.

TABLE 1.—AVERAGE PER PERSON DIETARY CONSUMPTION AND STRONTIUM-90 INTAKE, AUGUST–OCTOBER 1964 SAMPLIN G

Food category	Average U.S. consumption		Strontium-90 intake					
			New York City, August 1964		Chicago, October 1964		San Francisco, September 1964	
	Diet (kg/yr)	Calcium (g/yr)	pCi/kg *	pCi/yr	pCi/kg *	pCi/yr	pCi/kg *	pCi/yr
Bakery products	37	37.0	28.4±1.2	767	25.3±1.2	936	17.9±0.9	662
Whole grain products	11	10.0	96.1±2.2	1057	39.5±1.4	434	49.0±1.5	539
Eggs	16	9.1	6.5±0.1	104	9.4±0.2	150	6.0±0.1	96
Fresh vegetables	43	15.0	19.9±0.4	856	16.2±0.6	697	3.1±0.2	133
Root vegetables	17	6.1	8.2±0.2	139	13.6±0.4	231	5.9±0.3	100
Milk	221	234.3	24.0	5304	12.0±0.4	2652	4.8±0.4	1061
Poultry	17	9.2	3.7±0.1	63	2.6±0.4	44	3.4±0.1	58
Fresh fish	8	10.8	1.6±0.1	13	2.9±0.2	23	0.7±0.1	6
Flour	43	8.6	20.8±0.4	894	26.9±0.5	1157	10.8±0.2	464
Macaroni	3	0.7	15.0±0.4	45	20.1±0.5	60	11.2±0.3	34
Rice	3	1.1	5.4±0.2	16	6.0±0.2	18	3.2±0.2	9
Meat	73	10.9	2.0±0.1	146	1.6±0.2	117	2.2±0.1	161
Shellfish	1	0.8	1.8±0.1	2	0.8±0.1	1	1.3±0.2	1
Dried beans	3	2.9	30.3±1.8	91	34.9±2.3	105	21.3±1.5	64
Fresh fruit	68	12.6	11.3±0.4	768	3.3±0.2	224	2.0±0.2	136
Potatoes	45	5.8	9.9±0.4	446	13.4±0.6	603	1.3±1.6	58
Canned fruit	26	1.3	3.0±0.2	78	4.7±0.2	122	1.7±0.1	44
Fruit juices	19	1.7	2.1±0.2	40	4.8±0.3	91	4.5±0.2	86
Canned vegetables	20	4.2	22.8±0.7	456	18.6±0.8	372	2.4±0.3	48
Annual intake	674	383.		11285		7937		3760
pCi ^{90}Sr/g Ca in total diet			29.5		20.7		9.8	

* Error terms are one standard deviation (due to counting).

Results of the August-October 1964 sampling are presented in table 1. The variation with time of the daily intake of strontium–90 in the three cities is plotted in figure 1.

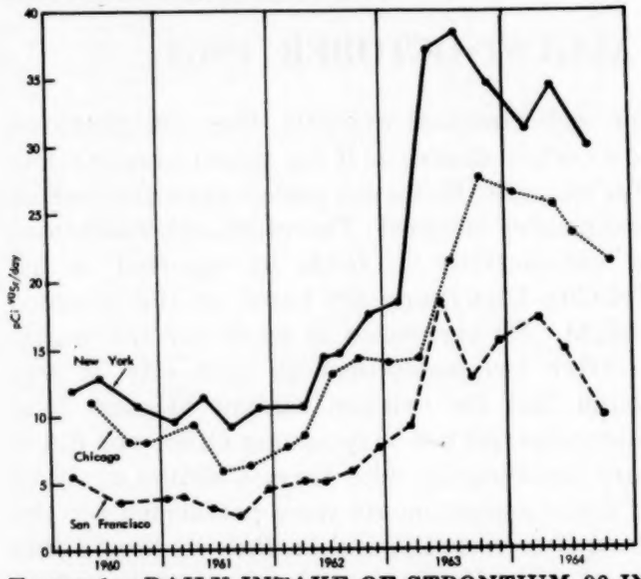

FIGURE 1.—DAILY INTAKE OF STRONTIUM–90 IN TRI-CITY TOTAL DIETS

In New York the strontium–90 intake is observed to decrease with respect to the previous samplings three months earlier. The San Francisco and Chicago strontium–90 intakes are observed to decrease as they have over the previous two sampling periods. This trend can be expected to continue with the discontinuation of atmospheric nuclear testing.

Discussion

The previously noted geographic distribution pattern of strontium–90 in the diet is seen to persist as it has since the initial samplings in 1960. Levels have been highest in New York City and lowest in San Francisco. Due in part to its high annual consumption, milk continues to be the predominant source of strontium–90 in diet.

REFERENCES

(*1*) U. S. DEPARTMENT OF AGRICULTURE. Food consumption of households in the United States, Report No. 1, 1955. Household Food Consumption Survey, Superintendent of Documents, Government Printing Office, Washington, D. C. 20402 (December 1956), price $1.00.

(*2*) U. S. ATOMIC ENERGY COMMISSION. Fallout program quarterly summary report. HASL–144:281–287, Office of Technical Services, Department of Commerce, Washington, D. C. 20230 (April 1, 1964), price $4.00. Summarized in Rad Health Data 5: 285–288 (June 1964).

(*3*) RIVERA, J. and J. H. HARLEY. HASL contributions to the study of fallout in food chains. HASL–147, Office of Technical Services, Department of Commerce, Washington, D. C. 20230 (July 1, 1964), price $1.50.

Recent coverage in *Radiological Health Data:*

Period	Issue
Thirteenth sampling (May–July 1963)	*March 1964*
Fourteenth sampling (August–October 1963)	*June 1964*
Fifteenth sampling (November 1963–January 1964)	*September 1964*
Sixteenth Sampling (February 1964–April 1964)	*December 1964*
Seventeenth Sampling (July–September 1964)	*March 1965*

Section III—Water

GROSS RADIOACTIVITY IN SURFACE WATERS OF THE UNITED STATES, DECEMBER 1964

Division of Water Supply and Pollution Control, Public Health Service

Levels of radioactivity in surface waters of the United States have been monitored by the Public Health Service Water Pollution Surveillance System since its initiation in 1957. Beginning with the establishment of 50 sampling points, this system has been expanded to 131 stations as of May 1, 1965. These are operated jointly with other Federal, State, and local agencies, and industry. Samples are taken from surface waters of all major U.S. river basins for physical, chemical, biological, and radiological analyses. These data can be used for evaluating sources of radioactivity which may affect specific domestic, commercial, and recreational uses of surface water. Further, the system provides background information necessary for recognizing pollution and water quality trends and for determining current and general levels of radioactivity to which the population may be exposed. Data assembled through the system and exact locations of sampling points are published in annual compilations (*1–6*).

Sampling procedures

The participating agencies collect one-liter "grab" samples each week and ship them "as is" to the Surveillance System Laboratory in Cincinnati for analysis. Gross alpha and gross beta radioactivity determinations on the suspended and dissolved solids are performed as frequently as deemed necessary.

Presently, gross alpha and beta determinations are made either on monthly composites of the weekly samples or on each weekly sample. Weekly alpha and beta determinations are scheduled for stations located downstream from known potential sources of radioactive waste. Weekly analyses are conducted at all newly established stations for the first year of operation. Weekly analyses are also scheduled for selected stations in an effort to detect short term radioactivity effects from current or recent nuclear tests or events.

Normally samples are counted within two weeks following collection or within one week after compositing. The decay of activity is followed on each sample for which the first analysis shows unusually high activity. Also, if a recount indicates that the original analysis was questionable, values based on recounting are recorded. All results are reported for the time of counting and are not extrapolated to the time of collection.

Strontium–90 analyses are performed on total solids of three-month composite of the weekly samples. The most recent strontium–90 results are presented in the March 1965 *RHD*.

Analytical methods

The analytical method used for determining gross alpha and beta radioactivity is described in the eleventh edition of "Standard Methods

for the Examination of Water and Wastewater" (*7*). Suspended and dissolved solids are separated by passing the sample through a membrane filter (type HA) with a pore size of 0.45 micron. Planchets are then prepared for counting the dissolved solids (in the filtrate) and the suspended solids (on the charred membrane filter) in an internal proportional counter. Reference sources of U_3O_8, which give a known count rate if the instrument is performing properly, are used for daily checking of the counter.

Results

Table 1 presents December 1964 results of alpha and beta analyses of U.S. surface waters. The stations on a river are arranged in the table according to their relative location on the river, the first stations listed being closest to the headwaters. These data are preliminary. The figures for gross alpha and gross beta radioactivity represent either determinations on composite samples or means of weekly determinations where composites were not made. The monthly means are reported to the nearest pCi/liter. When all samples have zero pCi/liter, the mean is reported as zero; when the calculated mean is between zero and 0.5 the mean is reported as <1 pCi/liter.

A geographical perspective of the radioactivity in surface water is obtained from the numbers printed near the stations as shown in figure 1 which gives the average total beta activity in suspended-plus-dissolved solids in raw water collected at each station. Gross radioactivity results for the year 1957–1962 have been summarized by Weaver *et al* (*8*).

The radioactivity associated with dissolved solids provides a rough indication of the levels which could occur in treated water, since nearly all suspended matter is removed by the treatment process (*9*). The Public Health Service Drinking Water Standards state that in the

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS, DECEMBER 1964[a]

Station	Beta activity, pCi/liter			Alpha activity, pCi/liter		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Animas River:						
Cedar Hill, N. Mex.	21	16	37	5	1	6
Arkansas River:						
Coolidge, Kans.	5	52	57	1	26	27
Ponca City, Okla.	9	7	16	3	4	7
Atchafalaya River:						
Morgan City, La.	86	13	99	26	1	27
Bear River:						
Preston, Idaho	1	15	16	0	0	0
Big Horn River:						
Hardin, Mont.	2	13	15	1	8	9
Chena River:						
Fairbanks, Alaska	2	1	3	0	0	0
Clinch River:						
Clinton, Tenn.	2	8	10	0	0	0
Kingston, Tenn.	2	39	41	0	<1	<1
Colorado River:						
Loma, Colo.	0	29	29	0	2	2
Page, Ariz.	1	32	33	0	7	7
Parker Dam, Calif.-Ariz.	1	16	17	0	3	3
Columbia River:						
Wenatchee, Wash.	1	9	10	0	1	1
Pasco, Wash.	42	801	843	0	1	1
Clatskanie, Ore.	31	38	69	2	0	2
Connecticut River:[b]						
Enfield Dam, Conn.	2	9	11	1	0	1
Coosa River:						
Rome, Ga.	5	6	11	0	0	0
Cumberland River:						
Cheatham Lock, Tenn.	2	9	11	1	0	1
Delaware River:						
Philadelphia, Pa.	2	5	7	1	0	1
Great Lakes:						
Duluth, Minn.	0	3	3	0	0	0
Hudson River:						
Poughkeepsie, N.Y.	8	20	28	1	1	2
Kansas River:						
De Soto, Kans.	2	30	32	0	3	3
Maumee River:						
Toledo, Ohio	6	20	26	1	0	1
Mississippi River:						
St. Paul, Minn.	4	20	24	0	2	2
E. St. Louis, Ill.	5	18	23	1	1	2
New Roads, La.	11	11	22	6	1	7
New Orleans, La.	14	11	25	3	0	3
Missouri River:						
Williston, N. Dak.	9	18	27	5	5	10
St. Joseph, Mo.	6	33	39	0	5	5
North Platte River:						
Henry, Nebr.	6	34	40	0	27	27
Ohio River:						
Cairo, Ill.	8	8	16	7	0	7
Toronto, Ohio	2	9	11	0	0	0
Platte River:						
Plattsmouth, Nebr.	8	24	32	1	5	6
Potomac River:						
Washington, D.C.	3	7	10	1	0	1
Red River, North:						
Grand Forks, N. Dak.	2	39	41	0	1	1
Red River, South:						
Alexandria, La.	10	8	18	4	0	4
Rio Grande:						
El Paso, Tex.	12	43	55	1	2	3
Laredo, Tex.	2	13	15	0	3	3
San Joaquin River:						
Vernalis, Calif.	2	3	5	0	1	1
San Juan River:						
Shiprock, N. Mex.	24	34	58	5	12	17
Savannah River:						
Port Wentworth, Ga.	3	8	11	0	0	0
Snake River:						
Wawawai, Wash.	3	12	15	0	2	2
South Platte River:						
Julesburg, Colo.	23	60	83	5	33	38
Tennessee River:						
Chattanooga, Tenn.	1	9	10	<1	0	<1
Wabash River:						
New Harmony, Ind.	3	13	16	0	0	0
Yellowstone River:						
Sidney, Mont.	0	16	16	1	5	6
Maximum	86	801	843	26	33	38
Minimum	0	1	3	0	0	0

[a] These data are preliminary: reanalysis of some samples may be made and additional analysis not completed at the time of the report may become available. For final data, one should consult the system's annual report.

[b] Because of the nature of the nuclides present in the Columbia River below the Pacific Northwest Laboratory (Hanford Plant), gross beta activity at this station is not directly comparable to gross beta activity at other stations.

FIGURE 1.—SAMPLING LOCATIONS AND ASSOCIATED TOTAL BETA ACTIVITY (pCi/liter) IN SURFACE WATERS, DECEMBER 1964

absence of strontium–90 and alpha emitters,[1] a water supply is acceptable when the gross beta concentration does not exceed 1,000 pCi/liter (*10*).

During December 1964, the highest reported level was at Pasco, Washington, where the average monthly total gross beta activity concentration was 843 pCi/liter. However, because of the nature of the radionuclides present in the Columbia River below Hanford, it is important to note that this value is not directly comparable to gross beta activity at other stations.

REFERENCES

(*1*) DIVISION OF WATER SUPPLY AND POLLUTION CONTROL, PUBLIC HEALTH SERVICE. National water quality network annual compilation of data. PHS Publication No. 663, 1958 Edition, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. Price $1.50.

(*2*) *Ibid.*, 1959 Edition. Price $1.75.

(*3*) *Ibid.*, 1960 Edition.[2]

(*4*) *Ibid.*, 1961 Edition.[2]

(*5*) *Ibid.*, 1962 Edition.[2]

(*6*) DIVISION OF WATER SUPPLY AND POLLUTION CONTROL, PUBLIC HEALTH SERVICE. Water pollution surveillance system annual compilation of data. PHS Publication No. 663 (Revised) 1963 ed., Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

(*7*) AMERICAN PUBLIC HEALTH ASSOCIATION; AMERICAN WATER WORKS ASSOCIATION AND WATER POLLUTION CONTROL FEDERATION. Standard methods for the examination of water and wastewater. 11th Edition, New York (1960).

(*8*) WEAVER, L., A. W. HOADLEY, and S. BAKER. Radioactivity in surface waters of the United States, 1957–1962. Rad Health Data 4: 306–16 (June 1963).

(*9*) STRAUB, C. P. Significance of radioactivity data. JAWWA 53:704 (June 1961).

(*10*) PUBLIC HEALTH SERVICE. Drinking water standards, revised 1962. Public Health Service Publication No. 956, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402 (March 1963), Price 30 cents.

[1] Absence is taken here to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha emitters and strontium–90, respectively.

[2] Single free copies of this publication may be obtained from: Public Inquiries Branch, Public Health Service, U. S. Department of Health, Education, and Welfare, Washington, D. C. 20201.

RADIOSTRONTIUM IN TAP WATER,[1] JANUARY–DECEMBER 1964

Health and Safety Laboratory
U.S. Atomic Energy Commission

The Health and Safety Laboratory has performed analyses for strontium–90 in tap water at New York City since August 1954. At Richmond, California, the sampling of tap water began in April 1958 and continued through June 1963. Samples of tap water are collected daily so that by the end of the month a composite of at least 100 liters is available for analysis. Strontium–89 determinations, which had been made since September 1961, were discontinued after the January 1964 sampling. The analytical methods used at the Laboratory are given in the Health and Safety Laboratory Manual of Standard Procedures (*1*).

Strontium–90 concentrations in New York City tap water are presented in table 1 for the period of November 1963 to December 1964. These results appear graphically in figure 1 along with Richmond, California, results since 1958. Data prior to 1958 appear in an earlier HASL report (*2*).

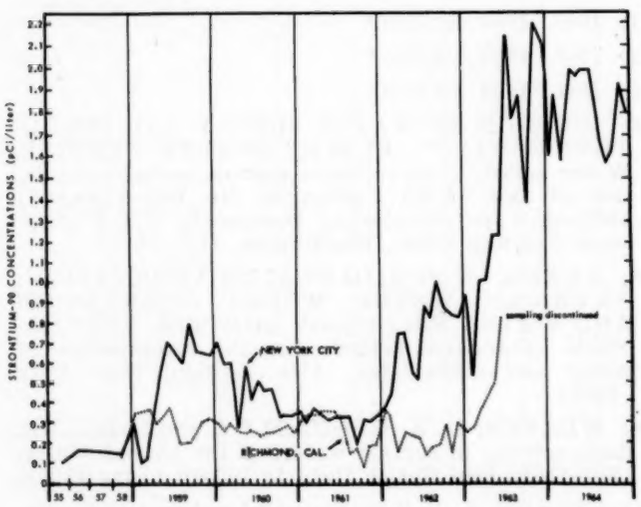

FIGURE 1.—STRONTIUM–90 CONCENTRATIONS IN TAP WATER

Recent coverage in *Radiological Health Data:*

Period	Issue
March–June 1962	*January 1963*
July–December 1962	*July 1963*
January–April 1963	*January 1964*
May–October 1963	*April 1964*

A decreasing trend has been observed in the strontium–90 concentrations since the July 1963 peak. The maximum strontium–90 concentrations observed are below the acceptable limit as set forth in the interstate carrier drinking water standards (*3*).

The strontium–89/strontium–90 ratios were discontinued when the ratio fell below 0.1.

TABLE 1.—RADIOSTRONTIUM IN NEW YORK CITY TAP WATER, 1959–DECEMBER 1964

Period	^{90}Sr [a] (pCi/liter)	$^{89}Sr/^{90}Sr$ [b]
1959 average	0.40	
1960 average	0.47	
1961 average	0.32	
1962 average	0.72	
1963		
November	2.20	0.4
December	2.02	0.4
1963 average	1.45	
1964		
January	1.62	<0.1
February	1.86	[c] NA
March	1.59	NA
April	1.98	NA
May	1.96	NA
June	1.98	NA
July	1.98	NA
August	1.68	NA
September	1.54	NA
October	1.61	NA
November	1.92	NA
December	1.80	NA
1964 average	1.79	

[a] From 100–200 liters per sample.
[b] Strontium-89 extrapolated to midpoint of sampling period. Strontium-89 analyses discontinued after January 1964.
[c] NA indicates no analysis performed (see text).

REFERENCES

(*1*) U.S. ATOMIC ENERGY COMMISSION. Manual of standard procedures. 40:E–38–01–16. Health & Safety Laboratory, U.S. Atomic Energy Commission, 376 Hudson St., New York 14, N.Y.

(*2*) U.S. ATOMIC ENERGY COMMISSION. Environmental contamination from weapons tests. HASL–42, Office of Technical Services, Department of Commerce, Washington, D.C. 20230 (October 1962).

(*3*) PUBLIC HEALTH SERVICE, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE. Federal register rules and regulations. Title 42, Public Health, Chapter 1, Part 72: Interstate quarantine, Subpart J, Drinking Water Standards. 27:2154–2155. Superintendent of Documents, Government Printing Office, Washington, D.C. 20402 (March 6, 1962).

[1] Data taken from AEC Fallout Program Quarterly Sumary Report, HASL–155: 199–207, Office of Technical Services, U.S. Department of Commerce, Washington, D.C. 20230 (January 1, 1965).

Section IV—Other Data

ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS

The U.S. Atomic Energy Commission receives from its contractors semi-annual reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

Summaries of the environmental radioactivity data for 22 AEC installations have appeared periodically in *RHD* since November 1960. Summaries follow for Brookhaven National Laboratory and Rocky Flats Plant.

Releases of radioactive materials from these installations for the periods covered in the reports below are governed by standards set forth in appropriate chapters of the AEC manual. The radioactivity concentration limits applicable to effluents released from AEC installations are essentially those published in the Federal Register (*1*).

1. Brookhaven National Laboratory July–December 1964

Associated Universities, Inc.
Upton, New York

The Brookhaven National Laboratory (BNL) operations may affect the environmental levels of radiation in three ways: (1) by discharge of coolant air from the graphite research reactor, (2) by radiation from an ecology forest gamma source, and (3) by the discharge of low-level radioactive liquid wastes into a small stream that forms one of the headwaters of the Peconic River (figure 1).

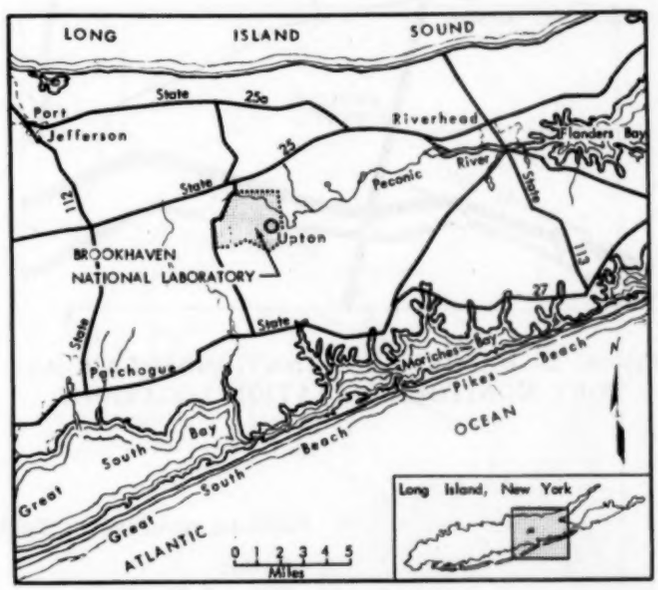

FIGURE 1.—BROOKHAVEN NATIONAL LABORATORY AND SURROUNDING AREA

Area monitoring

The radioactivity in the discharge coolant air is almost entirely due to argon–41, a beta-gamma emitter. Because exposure to argon–41 is due to external gamma, the monitoring is performed by measuring the exposure rate in milliroentgens per week (mR/wk) rather than the concentration in air.

Late in 1961 a 10,000-curie cesium–137 gamma source was installed in the ecology forest about 800 meters equidistant from the north and east boundaries (*2*).

Table 1 presents the average external gamma exposure rates measured at the four stations shown in figure 2. The higher levels at the Northeast perimeter station are primarily due to the ecology forest source. The environmental maximum permissible dose recommended by the Federal Radiation Council is 0.5 rem/yr (10 mrem/wk) above the natural background, averaged over a one-year period.

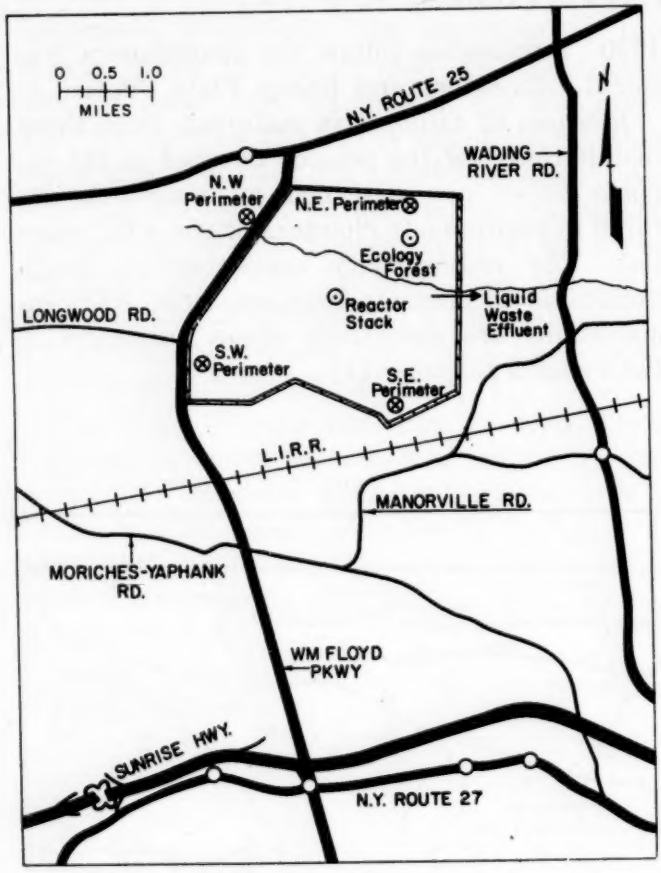

FIGURE 2.—BROOKHAVEN NATIONAL LABORATORY MONITORING STATION LOCATIONS

TABLE 1.—EXTERNAL GAMMA LEVELS AT BNL SITE BOUNDARY

(Average exposure rates in mR/wk)

Period	Northwest perimeter [a]	Southwest perimeter	Southeast perimeter	Northeast perimeter
Gamma exposure from laboratory operations:				
First half 1964	0.25	0.43	0.52	2.33
Second half 1964				
July	0.08	0.32	0.41	4.34
August	0.19	0.38	0.37	3.51
September	0.08	0.61	0.11	2.70
October	0.09	0.16	0.70	2.38
November	0.30	0.20	0.36	2.02
December	0.05	0.10	0.41	1.81
Second half 1964	0.12	0.30	0.39	2.82
Undisturbed background:				
First half 1964	2.78	2.90	3.13	3.28
Second half 1964	2.69	2.73	3.17	3.07

[a] Northwest perimeter station is located 680 meters inside boundary, and is designated "N. Gate" in figure 2. The others are on the boundary.

Water monitoring

The BNL liquid waste effluent is monitored for gross beta concentrations at the site boundary. Table 2 presents the average concentration together with the total activity released as determined by using known effluent flow rates.

TABLE 2.—GROSS BETA ACTIVITY IN BNL LIQUID WASTE EFFLUENT, JANUARY–DECEMBER 1964

Period	Average beta concentration (pCi/liter)	Total beta activity discharged (mCi)
First half 1964	75	42.4
Second half 1964		
July	82	6.9
August	72	6.8
September	60	5.7
October	71	5.9
November	59	4.1
December	54	4.6
Second half 1964	66	34.0

Previous coverage in *Radiological Health Data:*

Period	Issue
Third & fourth quarters 1961	*June 1962*
First & second quarters 1962	*January 1963*
July 1962 to June 1963	*February 1964*
July 1963 to June 1964	*December 1964*

2. Rocky Flats Plant
July–December 1964

Dow Chemical Company
Golden, Colorado

The Rocky Flats Plant (RFP) is engaged in routine production operations involving plutonium and uranium under contract to the Atomic Energy Commission. Its location relative to population centers is shown in figure 3. To assure properly controlled release of radioactive materials to the environment, periodic samples of water, air, and vegetation are analyzed for gross alpha activity. The most abundant radioactive material involved in the process is plutonium.

The plant is located about 15 miles northwest of Denver. The surface stratum in this area consists of gravel washed out of the highly mineralized Front Range of the Rocky Mountains, where heterogeneous low-level deposits of uranium, thorium, and radium exist in the soil. These materials are measurable in most samples of air, water, and vegetation.

Air

Continuous 24-hour air samples were collected at Coal Creek Canyon, Marshall, Boulder, Lafayette, Broomfield, Wagner School, Golden, Denver, and Westminster. The monthly average long-lived gross alpha activities are shown in table 3. The alpha activity is believed to result entirely from naturally occurring materials.

TABLE 3.—LONG-LIVED ALPHA ACTIVITY IN PARTICULATES IN AIR, RFP

Period	Average alpha concentration (pCi/m^3)
1964	
July	0.006
August	0.012
September	0.009
October	0.019
November	0.007
December	0.008
July—December 1964	0.010

Water monitoring

Semi-monthly water samples were collected from four reservoirs at distances ranging from 3 to 8 miles from RFP. The average alpha concentrations in the four reservoirs during the second half of 1964 are shown in table 4.

TABLE 4.—ALPHA ACTIVITY IN WATER COLLECTED FROM RESERVOIRS IN THE VICINITY OF RFP

[Average concentrations in pCi/liter]

Reservoir	Second half 1964	1964
Great Western	2.0	2.3
Standley	2.7	2.7
Baseline	1.6	1.4
Ralston	1.0	2.3

Non-routine raw surface water samples were collected from a number of outlying streams and lakes along with the vegetation samples. The 35 samples collected during the second half of 1964 had an average gross alpha activity of 2.5 pCi/liter.

Vegetation Samples

A total of 116 vegetation samples were analyzed during 1964. The average gross alpha activities of these samples was 120 pCi/kg dry for samples collected within 3 miles of the plant, and 135 pCi/kg dry for those collected 3 to 18 miles from RFP.

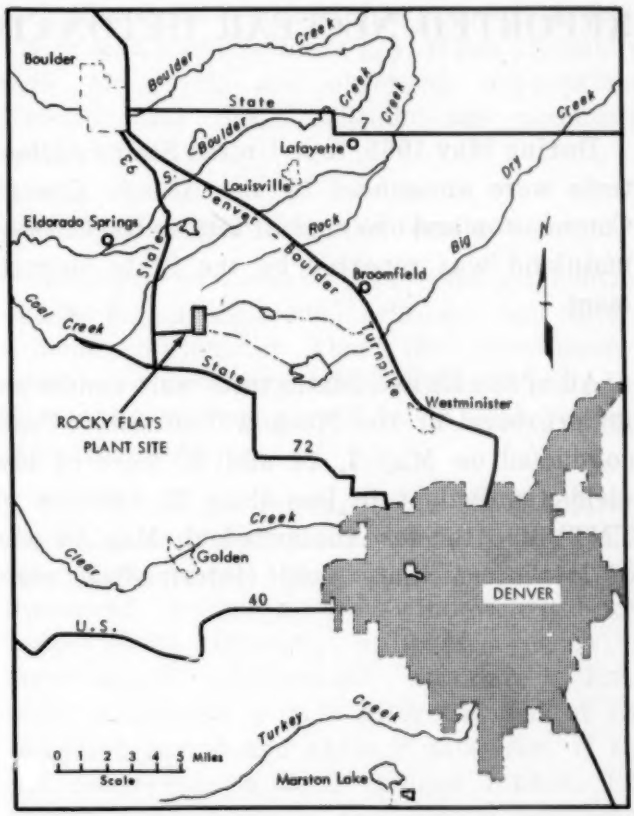

FIGURE 3.—LOCATION OF THE ROCKY FLATS PLANT ENVIRONMENT, DENVER, COLORADO

REFERENCES

(1) U.S. ATOMIC ENERGY COMMISSION. Rules and regulations, standards for protection against radiation. Title 10, CFR 20, Government Printing Office, Washington, D.C. 20402.
(2) HULL, A. P. 1962 environmental radiation levels at Brookhaven National Laboratory, BNL 807 (T-310) Health and Safety—TID—4500, 21st ed.) (May 1963). Office of Technical Services, Department of Commerce, Washington, D.C. 20430.

Recent coverage in *Radiological Health Data:*

Period	Issue
Second half 1961	*May 1962*
First half 1962	*January 1963*
July 1962–June 1963	*February 1964*
July 1963–June 1964	*December 1964*

REPORTED NUCLEAR DETONATIONS, MAY 1965

During May 1965, four United States nuclear tests were announced by the Atomic Energy Commission and one nuclear test on the Chinese mainland was reported by the State Department.

All of the United States tests were conducted underground at the Nevada Test Site. Tests conducted on May 7, 14 and 21 were of low yield (equivalent to less than 20 kilotons of TNT) and the test conducted on May 12 was of low-intermediate yield (intermediate yield is defined as equivalent to 20 to 200 kilotons of TNT).

The mainland Chinese test was announced to have occurred at 0200 Greenwich time, May 14, 1965. Early information indicated that the test was conducted in the atmosphere, involved a fission device using uranium–235, and was of somewhat higher yield than the Chinese detonation of October 16, 1964. Public Health Service field estimates and laboratory analyses of air samples confirmed the presence of fresh fission products consistent with the timing of the detonation.

Section I—Air and Fallout

GROSS BETA ACTIVITY IN AIRBORNE PARTICULATES AND PRECIPITATION

Continuous surveillance of gross beta activity in air and precipitation provides one of the earliest and most sensitive indications of changes in environmental fission product activity. Although this surveillance does not provide enough information to assess total human radiation exposure from fallout, it is used as an alerting system for determining when to intensify monitoring in other phases of the environment.

Surveillance data from a number of national programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the Public Health Service, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization.

1. Radiation Surveillance Network March 1965

Division of Radiological Health, Public Health Service

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Surveillance Network (RSN) of the PHS Division of Radiological Health, which regularly gathers samples from 75 stations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

Alerting function

The alerting function of the network is provided by field estimates of the gross beta activity of airborne particulates on the filters. These determinations are performed about 5 hours after the end of the sampling period to allow for decay of naturally-occurring radon daughters. The daily field readings are submitted to the Radiation Surveillance Center, Division of Radiological Health, Washington, D.C. These field estimates are reported elsewhere on a monthly basis (*1*). When unusually high air levels are observed, appropriate Federal and State officials are promptly notified.

Air sampling procedure and results

Airborne particulates are collected continuously on carbon-loaded cellulose dust filters 4 inches in diameter. About 1800 cubic meters or air are drawn through each filter during the 24-hour sampling period by a high volume centrifugal blower.

The filters are forwarded to the Radiation Surveillance Network laboratory in Rockville, Maryland, where the gross beta activity is measured using a thin-window, gas-flow proportional counter, calibrated with a strontium–90—yttrium–90 standard. Each filter is counted 4 days after the end of the sampling period and again 7 days later if the net count rate is 2000 cpm or higher. The initial 4-day aging of the sample eliminates interference from naturally occurring radon and thoron daughters. By using the two counts

Figure 1. Radiation Surveillance Network sampling stations

and the Way-Wigner formula (*2*), the age of fission products is estimated, and the activity extrapolated to the day of collection.[1] The March 1965 average gross beta concentrations in air for RSN stations are given in table 1. Time profiles of gross beta activity in air for eight RSN stations are shown in figure 2.

During March 1965, three air samples were analyzed by gamma spectrometry. The method discussed by Burrus (*3*) and Covell (*4*) has been adapted for resolving the spectral data. No air or precipitation samples were found to contain short-lived radionuclides.

Radioactivity in Precipitation

Continuous sampling for radioactivity in total precipitation is conducted at most stations on a daily basis, using funnels with collection areas of 0.4 square meter. A 500-ml portion of the collected precipitation is evaporated to dryness, and the residue is forwarded to the laboratory for analysis. If the collected sample is between 200 and 500 ml, the entire sample is evaporated. When a sample is smaller than 200 ml (equivalent to 0.5 mm or 0.02 inches of rainfall), the volume of precipitation is reported, but no analysis is made.

In the laboratory the gross beta activity in precipitation is determined by counting the evaporated sample by the same method used for analyzing the air filters, including the extrapolation to time of collection. Deposition for the sample is determined by:

$$D = \frac{CP}{1000}$$

where D is the deposition in nCi/m², C is the concentration in pCi/liter, and P is the depth of precipitation in mm. The individual values of deposition and depth of precipitation are totaled for the month. Total depths and deposition of radioactivity during March 1965 are presented in table 1.

[1] If a sample contains a mixture of fresh and old fission products, the age estimated by the Way-Wigner formula is some intermediate value; consequently the calculated age of the fresh component will be overestimated.

Table 1. Gross beta activity in surface air and precipitation, March 1965

Station location		Air surveillance					Precipitation measurements	
		Number of samples	Gross beta activity (pCi/m³)			Last profile in *RHD*	Total depth (mm)	Total deposition (nCi/m²)
			Maximum	Minimum	Average [a]			
Ala:	Montgomery	31	0.64	<0.10	<0.21	May 65	185.3	37.1
Alaska:	Adak	22	0.32	<0.10	<0.13	Nov 64	[b] —	—
	Anchorage	30	0.37	<0.10	<0.15	May 65	13.6	2.7
	Attu Island	29	1.17	<0.10	<0.16	Dec 64	—	—
	Fairbanks	11	0.29	<0.10	<0.14	June 65	7.9	1.7
	Juneau	9	0.60	<0.10	0.28	July 65	3.0	0.6
	Kodiak	15	0.17	<0.10	<0.10	Oct 64	—	—
	Nome	15	0.25	<0.10	<0.12	Feb 65	—	—
	Point Barrow	31	0.25	<0.10	<0.12	Jan 65	—	—
	St. Paul Island	22	0.21	<0.10	<0.11	Mar 65	—	—
Ariz:	Phoenix	29	1.05	0.23	0.53	July 65	—	—
Ark:	Little Rock	26	0.49	<0.10	0.21	June 65	94.8	19.9
Calif:	Berkeley	29	0.58	<0.10	0.26	Oct 64	37.8	8.2
	Los Angeles	31	0.86	<0.10	0.38	Feb 65	31.3	7.1
C. Z:	Ancon	18	0.19	<0.10	<0.12	Nov 64	—	—
Colo:	Denver	27	0.64	0.17	0.35	Oct 64	8.3	1.7
Conn:	Hartford	30	0.42	<0.10	<0.21	July 65	33.5	8.1
Del:	Dover	22	0.45	<0.10	<0.23	May 65	—	—
D. C:	Washington	29	0.59	<0.10	0.27	Feb 65	103.4	21.4
Fla:	Jacksonville	30	0.48	<0.10	<0.19	June 65	78.3	15.7
	Miami	30	0.75	<0.10	0.29	July 65	58.5	11.7
Ga:	Atlanta	19	0.27	<0.10	<0.15	Apr 65	41.8	8.5
Guam:	Agana	31	0.52	<0.10	0.19	Apr 65	—	—
Hawaii:	Honolulu	30	0.44	0.11	0.26	Dec 64	20.0	4.9
Idaho:	Boise	30	0.71	<0.10	0.36	Dec 64	14.6	2.9
Ill:	Springfield	29	0.41	<0.10	0.21	Feb 65	—	—
Ind:	Indianapolis	29	0.44	<0.10	0.21	Apr 65	47.2	10.2
Iowa:	Iowa City	30	0.60	<0.10	0.30	Nov 64	68.5	14.6
Kans:	Topeka	26	0.43	0.12	0.23	May 65	34.3	6.9
Ky:	Frankfort	23	0.45	<0.10	0.22	Feb 65	67.8	15.2
La:	New Orleans	26	0.41	<0.10	<0.18	Feb 65	109.1	22.3
Maine:	Augusta	17	0.67	0.13	0.28	Mar 65	—	—
	Presque Isle	30	0.56	<0.10	0.28	Nov 64	20.7	4.3
Md:	Baltimore	22	0.38	<0.10	<0.21	July 65	39.9	8.0
	Rockville	17	0.32	<0.10	<0.17	Jan 65	—	—
Mass:	Lawrence	31	0.50	<0.10	0.25	May 65	47.6	9.9
	Winchester	10	0.34	<0.10	<0.19	Dec 64	34.9	7.0
Mich:	Lansing	31	0.56	<0.10	0.27	Jan 65	—	—
Minn:	Minneapolis	21	0.30	<0.10	0.16	Apr 65	71.8	14.3
Miss:	Jackson	28	0.42	<0.10	<0.20	Mar 65	149.2	29.9
	Pascagoula	4	0.18	<0.10	<0.11	Dec 64	—	—
Mo:	Jefferson City	31	0.39	<0.10	0.20	Apr 65	69.2	18.6
Mont:	Helena	28	1.08	<0.10	0.36	Nov 64	21.0	4.5
Nebr:	Lincoln	22	0.79	<0.10	0.27	Mar 65	38.4	10.2
Nev:	Las Vegas	27	1.08	0.25	0.66	June 65	—	—
N. H:	Concord	21	0.60	<0.10	0.32	Feb 65	—	—
N. J:	Trenton	31	0.41	<0.10	<0.20	Mar 65	24.3	5.0
N. Mex:	Santa Fe	19	0.49	0.11	0.25	Nov 64	11.1	3.0
N. Y:	Albany	22	0.42	<0.10	0.23	Apr 65	31.7	6.3
	Buffalo	29	0.64	<0.10	0.28	Nov 64	—	—
	New York	31	0.53	<0.10	0.25	Dec 64	—	—
N. C:	Gastonia	28	0.61	<0.10	<0.24	Nov 64	151.0	30.8
N. Dak:	Bismarck	27	0.31	<0.10	0.17	Jan 65	12.8	2.7
Ohio:	Cincinnati	20	0.47	<0.10	0.21	May 65	—	—
	Columbus	30	0.79	<0.10	0.35	Mar 65	57.9	13.1
	Painesville	28	0.66	0.11	0.33	July 65	55.3	13.6
Okla:	Oklahoma City	29	0.42	<0.10	0.21	Jan 65	—	—
	Ponca City	31	0.27	<0.10	<0.14	July 65	30.7	6.1
Ore:	Portland	31	1.31	0.18	0.64	Mar 65	12.2	2.5
Pa:	Harrisburg	31	0.47	<0.10	<0.17	Apr 65	42.5	8.5
P. R:	San Juan	30	0.20	<0.10	<0.12	Mar 65	7.5	1.5
R. I:	Providence	29	0.53	<0.10	0.26	Jan 65	39.1	8.3
S. C:	Columbia	28	0.43	<0.10	<0.19	Dec 64	177.3	35.6
S. Dak:	Pierre	31	0.42	<0.10	0.21	July 65	—	—
Tenn:	Nashville	30	0.63	<0.10	0.24	Jan 65	139.6	29.1
Tex:	Austin	30	0.68	<0.10	0.26	May 65	42.0	11.4
	El Paso	31	0.90	0.13	0.51	Jan 65	1.3	0.3
Utah:	Salt Lake City	28	0.55	0.18	0.33	Feb 65	5.1	3.4
Vt:	Barre	27	0.66	<0.10	0.36	June 65	9.8	2.0
Va:	Richmond	28	0.34	<0.10	<0.17	June 65	104.3	21.6
Wash:	Seattle	30	0.78	<0.10	0.32	May 65	9.1	2.2
	Spokane	31	0.50	<0.10	0.28	Apr 65	—	—
W. Va:	Charleston	30	0.42	<0.10	0.23	Dec 64	106.2	24.3
Wis:	Madison	30	0.46	<0.10	0.24	June 65	54.0	11.5
Wyo:	Cheyenne	29	0.83	0.12	0.35	June 65	15.9	3.0
Network summary [c]		1958	1.31	<0.10	<0.25			

[a] The monthly average is calculated by weighting the individual samples with the length of sampling period. Values of <0.10 are assumed to be 0.10 for averaging purposes. If the <0.10 values represent more than 10 percent of the values used in the average, a less-than sign is placed before the average.

[b] Dash indicates no report received.

[c] For the network summary, all averages are arithmetic means of station averages.

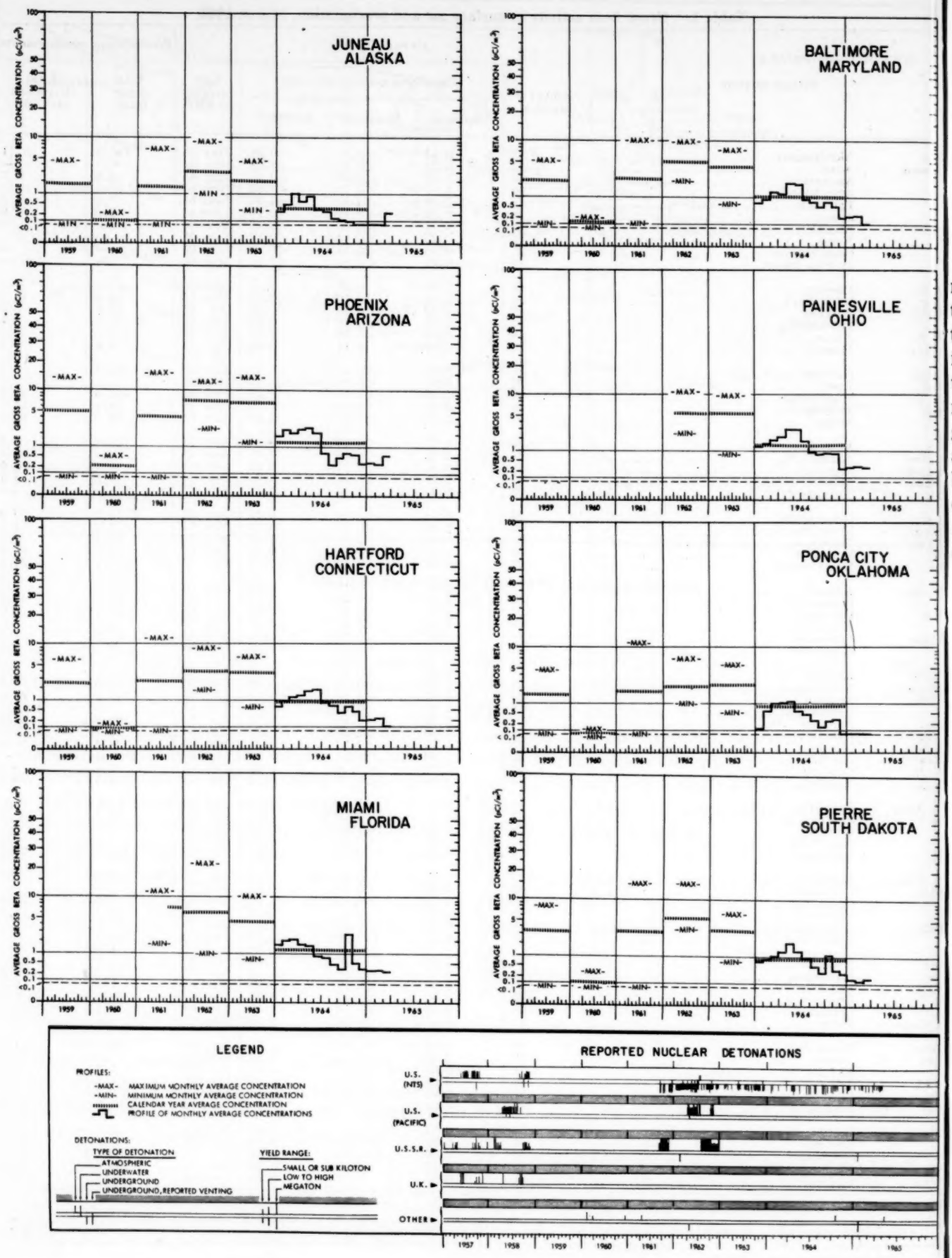

Figure 2. Monthly and yearly profiles of beta activity in air—Radiation Surveillance Network, 1959–March 1965

2. National Air Sampling Network, First Quarter 1965

Division of Air Pollution,
Public Health Service

The necessity of having basic data on the nature and extent of air pollution throughout the United States led to the organization of the National Air Sampling Network (NASN) in 1953. The NASN analyzes air samples for the total quantity of suspended particulate matter, benzene-soluble organic matter, and gross beta radioactivity. Selected samples are also analyzed for nitrates, sulfates, and a number of metals. The resulting data aid in the detection of trends in levels of pollution with respect to time, location, population density, climate and other factors.

Gross beta activity in air

NASN stations (figure 3) are manned by cooperating Federal, State and local agencies. The current basic network consists of 110 sampling stations which operate every year in 73 large cities and 37 nonurban areas. In addition, there are stations in 130 cities which operate every other year. Thus, the NASN consists of 240 sampling stations, 175 of which are active in any given year.

Continuous 24-hour samples of suspended particulate matter are taken at each station. The samples, representing approximately 2,000 cubic meters of air, are collected on glass fiber filters on a biweekly random sampling schedule. They are sent for analysis to the Network laboratory at the Robert A. Taft Sanitary Engineering Center in Cincinnati, Ohio. First quarter 1965 gross beta activities in air are given in table 2. An annual summary for 1964 was presented in the April 1965 issue of *RHD* (*5*).

Figure 3. National Air Sampling Network stations

Table 2. Gross beta activity in surface air, NASN, first quarter, 1965

(Concentrations in pCi/m³)

	Station Name	Number of samples	Maximum	Minimum	Average
Ala:	Birmingham	7	0.6	0.2	0.4
	Huntsville	7	0.5	0.2	0.4
	Montgomery	6	0.6	0.2	0.4
Alaska:	Anchorage	7	0.6	0.1	0.4
Ariz:	Grand Canyon Pk.*	6	0.9	0.1	0.4
	Maricopa County *	7	1.6	0.2	0.6
	Phoenix	7	1.5	0.2	0.7
	Tucson	6	1.0	0.2	0.5
Ark:	Little Rock	6	0.6	0.1	0.3
	Montgomery County *	5	0.5	0.1	0.3
Calif:	Glendale	6	1.2	0.2	0.6
	Humboldt County *	6	0.6	<0.1	0.2
	Long Beach	7	1.4	0.2	2.4
	Los Angeles	6	1.2	0.3	0.8
	Oakland	7	0.7	0.1	0.4
	San Diego	6	0.6	0.2	0.4
	San Francisco	7	0.7	0.1	0.3
Colo:	Denver	7	1.0	0.2	0.5
	Montezuma County *	6	1.4	0.2	0.7
Conn:	Hartford	7	0.5	0.3	0.4
	New Britain	7	0.8	0.3	0.4
	New Haven	7	0.5	0.3	0.4
	Norwich	7	0.6	0.3	0.4
	Waterbury	7	0.5	0.2	0.4
Del:	Kent County *	7	0.5	0.1	0.3
	Newark	7	0.5	0.2	0.3
	Wilmington	7	0.7	0.2	0.4
D. C:	Washington	6	0.4	0.2	0.3
Ga:	Atlanta	6	0.7	0.1	0.4
Hawaii:	Honolulu	7	0.5	0.1	0.3
Idaho:	Boise	7	0.7	0.1	0.4
	Butte County *	7	0.8	<0.1	0.3
Ill:	Chicago	5	0.6	0.2	0.4
	East St. Louis	7	0.5	0.1	0.4
	Joliet	6	0.5	0.3	0.4
	North Chicago	7	0.5	0.2	0.3
	Rockford	6	0.5	0.2	0.3
	Springfield	7	0.5	0.2	0.3
Ind:	East Chicago	7	0.5	0.2	0.4
	Hammond	7	0.5	0.2	0.3
	Indianapolis	6	0.5	0.2	0.4
	Muncie	5	0.6	0.2	0.4
	Parke County *	7	0.7	0.3	0.4
	Portage	7	0.5	0.2	0.4
	Beverly Shores	7	0.5	0.2	0.3
	Dunes Police Post No. 1	7	0.5	0.2	0.3
	Dunes State Park	7	0.4	0.2	0.3
	Ogden Dunes	7	0.4	<0.1	0.2
	South Bend	7	0.6	0.2	0.3
	Terre Haute	7	0.5	0.3	0.4
Iowa:	Cedar Rapids	7	0.4	0.2	0.3
	Delaware County *	7	0.4	0.2	0.3
	Des Moines	7	0.4	0.2	0.3
Kans:	Topeka	7	0.6	0.1	0.3
	Wichita	7	0.5	0.1	0.3
Ky:	Lexington	6	0.8	0.3	0.5
	Louisville	6	0.5	0.3	0.4
La:	New Orleans	7	0.6	0.1	0.4
	Shreveport	7	0.4	0.2	0.3
Maine:	Acadia Nat'l. Park *	7	0.7	0.2	0.4
	Portland	7	0.5	0.1	0.3
Md:	Baltimore	7	2.4	0.1	0.6
	Calvert County *	7	0.6	0.2	0.3
Mass:	Brockton	7	0.6	0.3	0.4
	Lawrence	7	0.8	0.2	0.5
	Lowell	7	0.7	0.2	0.5
	New Bedford	7	0.9	0.5	0.6
Mich:	Detroit	7	0.7	0.3	0.4
	Flint	7	0.4	0.1	0.3
	Grand Rapids	7	0.7	0.1	0.4
	Trenton	7	0.5	0.2	0.3
Minn:	Minneapolis	7	0.5	0.2	0.3
	St. Paul	7	0.5	0.2	0.3
Miss:	Jackson	7	0.8	0.2	0.4
	Jackson County *	7	0.4	0.2	0.3
Mo:	Kansas City	7	0.7	0.2	0.4
	St. Louis	7	0.5	0.2	0.3
	Shannon County *	7	0.7	0.2	0.4
Mont:	Glacier Nat'l. Park *	6	0.5	0.1	0.3
	Helena	7	1.0	0.2	0.5
Nebr:	Omaha	7	0.6	0.1	0.3
	Thomas County *	7	0.6	0.2	0.4
Nev:	Las Vegas	7	1.2	0.2	0.8
	Reno	6	1.1	0.1	0.6
	White Pine County *	6	0.8	0.1	0.4
N. H:	Concord	7	0.5	0.3	0.4
	Coos County *	7	0.6	0.2	0.4
N. J:	Bayonne	7	0.5	0.1	0.3
	Bridgeton	7	0.8	0.2	0.4
	Pemberton	7	0.5	0.1	0.3
	Marlton	7	0.7	0.1	0.4
	Glassboro	7	0.5	0.2	0.3
	Hamilton	6	0.5	0.1	0.3
	Jutland	6	0.7	0.3	0.4
	Jersey City	7	0.5	0.1	0.3
	Newark	7	0.5	0.1	0.3
	New Brunswick	7	0.4	0.1	0.3
	Paterson	7	0.5	0.2	0.4
	Perth Amboy	7	0.5	0.3	0.4
	Princeton	7	0.5	0.1	0.3
N. Mex:	Albuquerque	7	0.9	0.1	0.4
	Rio Arriba County *	6	1.0	0.1	0.5
N. Y:	Cape Vincent *	7	0.6	0.3	0.4
	New York City	7	0.7	0.2	0.4
N. C:	Charlotte	7	1.2	0.2	0.4
	Cape Hatteras *	7	0.6	0.2	0.4
Ohio:	Akron	7	0.7	0.3	0.4
	Cincinnati	6	0.6	0.3	0.4
	Cleveland	7	0.5	0.1	0.3
	Columbus	7	0.5	0.2	0.3
	Toledo	7	0.5	0.2	0.3
	Youngstown	7	0.5	0.2	0.3
Okla:	Cherokee County *	7	0.4	0.2	0.3
	Oklahoma City	7	0.4	0.1	0.3
	Tulsa	7	0.4	0.1	0.3
Ore:	Curry County *	6	0.5	<0.1	0.3
	Eugene	7	0.5	<0.1	0.2
	Medford	7	0.9	<0.1	0.3
	Pottland	7	0.8	<0.1	0.4
Pa:	Allentown	7	0.5	0.1	0.4
	Altoona	5	0.7	0.1	0.4
	Bethlehem	7	0.5	0.1	0.3
	Pipersville	6	0.4	0.1	0.3
	Embreeville	7	0.4	0.2	0.3
	Clarion County *	7	0.5	0.2	0.3
	Erie	7	0.5	0.2	0.4
	Johnstown	6	0.5	0.2	0.4
	Lancaster	7	0.6	0.1	0.3
	Eagleville	7	0.4	0.1	0.2
	Sanatoga	7	0.4	0.2	0.3
	Philadelphia	7	0.4	0.2	0.3
	Pittsburgh	7	0.6	0.2	0.3
	Reading	7	0.6	0.1	0.4
	Scranton	4	0.4	0.2	0.3
	Warminster	6	0.5	0.2	0.4
	West Chester	7	0.4	0.2	0.3
	York	7	0.8	0.1	0.5
P. R:	Bayamon	6	0.6	0.1	0.3
	Guayanilla	3	0.7	0.1	0.4
	Ponce	3	0.4	0.2	0.3
	San Juan	7	0.2	0.1	0.2
R. I:	East Providence	7	0.6	0.1	0.3
	Providence	7	0.6	0.2	0.4
	Washington County *	7	0.7	0.2	0.4
S. C:	Charleston	7	0.8	0.1	0.4
	Columbia	6	1.7	0.2	0.9
	Richland County *	6	0.6	0.3	0.4
	Spartanburg	6	0.5	0.1	0.3
S. Dak:	Black Hills Forest *	7	0.7	0.1	0.4
	Sioux Falls	7	0.6	0.2	0.4
Tenn:	Chattanooga	7	0.7	0.1	0.4
	Knoxville	7	0.5	0.1	0.3
	Memphis	7	0.6	0.3	0.4
	Nashville	7	0.5	0.3	0.4
Tex:	Dallas	7	0.6	0.1	0.4
	Houston	6	0.5	0.3	0.4
	Matagorda County *	6	0.7	0.3	0.4
	San Antonio	7	0.6	0.1	0.4
Utah:	Salt Lake City	7	0.8	0.2	0.5
Vt:	Burlington	7	0.6	0.2	0.4
	Orange County *	7	0.5	0.3	0.4
Va:	Hampton	7	0.5	0.1	0.3
	Lynchburg	7	0.7	0.1	0.4
	Norfolk	6	0.7	0.2	0.4
	Shenandoah Nat'l. Park *	7	0.6	0.1	0.4
	Portsmouth	7	0.4	0.2	0.3
	Richmond	7	0.7	0.1	0.4
	Roanoke	7	0.9	0.3	0.5
Wash:	Seattle	7	0.5	0.1	0.2
W. Va:	Charleston	7	0.6	0.3	0.4
	Weirton	7	0.4	0.2	0.3
	Wheeling	7	0.5	0.1	0.3
Wis:	Door County *	5	0.5	0.2	0.3
	Kenosha	7	0.6	0.2	0.4
	Madison	7	0.5	0.2	0.3
	Milwaukee	7	0.5	0.2	0.4
Wyo:	Cheyenne	7	0.6	0.2	0.4
	Yellowstone Park *	7	0.9	0.2	0.5
Network summary		1,185	2.4	<0.1	0.4

* Denotes nonurban station.

3. Canadian Air Monitoring Program[2] March 1965

Department of National Health and Welfare

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (figure 4), where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*6–10*).

[2] Data from RADIATION PROTECTION DIVISION. *Radiation Protection Programs*, Vol. 3, No. 4: 19–25 (April 1965), Canadian Department of National Health and Welfare, Ottawa, Canada.

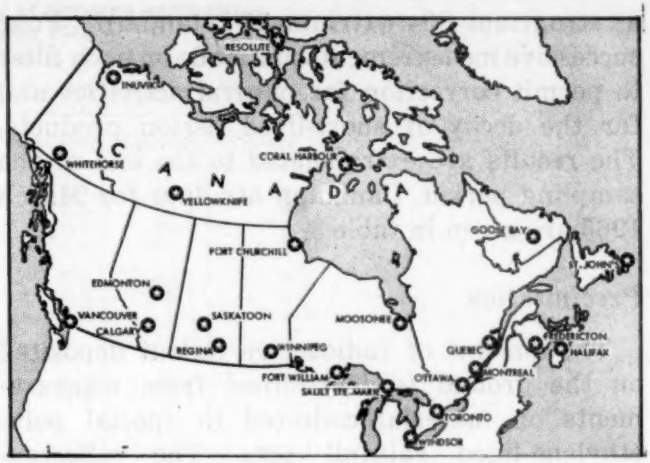

Figure 4. Canadian air and precipiation sampling stations

Air

Each air sample involves the collection of particulates from about 650 cubic meters of air drawn through a high-efficiency 4-inch-diameter glass fiber filter during a 24-hour period. These filters are sent daily to the Radiation Protection Division Laboratory in Ottawa. A 2-inch-diameter disk is cut from each filter and counted with a thin-end-window, gas-flow, Geiger-Mueller counter system calibrated with

Table 3. Gross beta activity in surface air and precipitation, Canada, March 1965

Station location	Air surveillance				Precipitation measurements	
	Number of samples	Gross beta activity (pCi/m³)			Average concentration, (pCi/liter)	Total deposition (nCi/m²)
		Maximum	Minimum	Average		
Calgary	31	0.7	0.1	0.4	188	3.0
Coral Harbour	31	0.5	0.1	0.2	110	1.8
Edmonton	31	0.4	0.1	0.3	138	1.6
Ft. Churchill	31	0.5	0.1	0.2	211	1.2
Ft. William	31	0.5	0.2	0.3	116	4.0
Fredericton	30	0.5	0.0	0.2	107	2.5
Goose Bay	31	0.4	0.0	0.2	46	5.1
Halifax	31	0.5	0.0	0.2	92	3.8
Inuvik	31	0.5	0.2	0.3	175	1.8
Montreal	31	0.6	0.1	0.3	141	2.6
Moosonee	31	0.5	0.2	0.3	171	1.1
Ottawa	31	0.5	0.1	0.3	92	2.0
Quebec	31	0.4	0.1	0.3	246	4.1
Regina	31	0.4	0.0	0.3	467	2.7
Resolute	28	0.5	0.2	0.3	362	2.0
St. John's, Nfld	29	0.2	0.0	0.1	72	9.1
Saskatoon	31	0.3	0.1	0.2	554	1.7
Sault Ste. Marie	31	0.6	0.2	0.3	73	2.2
Toronto	30	0.5	0.1	0.3	75	4.2
Vancouver	31	0.6	0.0	0.4	227	9.8
Whitehorse	31	0.5	0.1	0.3	361	1.5
Windsor	30	0.6	0.1	0.3	98	7.4
Winnipeg	31	0.4	0.2	0.3	120	1.6
Yellowknife	31	0.4	0.1	0.2	504	1.8
Network summary	736	0.7	0.0	0.3	198	3.3

a strontium–90—yttrium–90 standard. Four successive measurements are made on each filter to permit correction for natural activities and for the decay of short-lived fission products. The results are extrapolated to the end of the sampling period. Canadian air data for March 1965 are given in table 3.

Precipitation

The amount of radioactive fallout deposited on the ground is determined from measurements on material collected in special polyethylene-lined rainfall pots. The collection period for each sample is one month. After transfer of the water to the sample container, the polyethylene liner is removed, packed with the sample, and sent to the laboratory.

Strontium and cesium carriers are added to all samples on arrival at the laboratory. Other carriers are added to selected samples according to the specific radionuclides to be determined. The samples are then filtered and the filtrate evaporated to near dryness. The filter paper containing insoluble matter is then ignited together with the polyethylene liner at 450° C. The ash is combined with the soluble fraction, transferred to a glass planchet, evaporated under an infra-red lamp, and then counted with a thin-end-window Geiger-Mueller counter calibrated with a strontium–90—yttrium–90 source. Gross beta activities for March 1965 samples are given in table 3. Radionuclide analyses are reported quarterly in *RHD*.

4. Mexican Air Monitoring Program March 1965

National Commission of Nuclear Energy

The Radiation Surveillance Network of Mexico was established by the Comisión Nacional de Energía Nuclear (CNEN), Mexico City. From 1952 to 1961 the network was directed by the Institute of Physics of the University of Mexico, under contract to the CNEN (*11–15*).

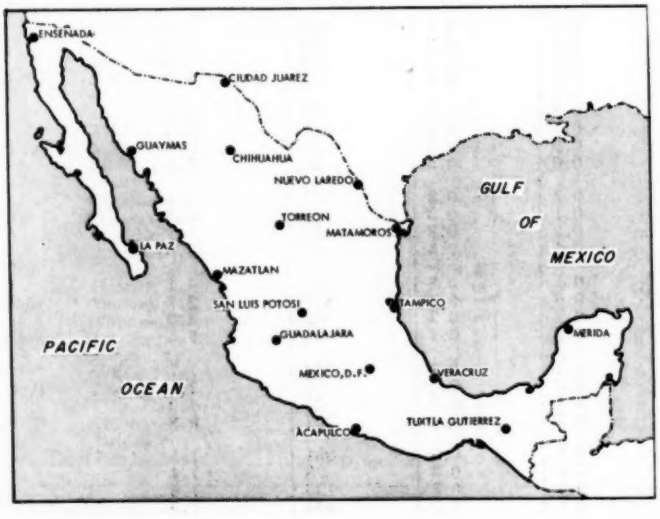

Figure 5. Fallout Network sampling stations in Mexico

In 1961 the CNEN appointed its Division of Radiological Protection to establish a new Radiation Surveillance network. This consists of 17 stations (figure 5), twelve of which are located at airports and operated by airline personnel. The other stations are located at Mexico City, Mérida, Veracruz, San Luis Potosí, and Ensenada.

Sampling

The sampling procedure involves drawing air for 24 hours a day, 3 or 4 days a week at the rate of approximately 1,200 cubic meters per day, through a high-efficiency, 6 x 8-inch glass fiber filter, using high volume samplers. After each 24 hour sampling period, the filter is removed and forwarded via air mail to the "Laboratorio de Estudios sobre Contaminación Radiactiva", CNEN, in Mexico City for assay of gross beta activity. A minimum of 3 or 4 days after collection is allowed for decay of radon and thoron daughter natural radioactivity. Data are not extrapolated to the date of collection.

Results

The maximum, minimum, and average fission product beta concentrations in surface air during March 1965 are presented in table 4.

Table 4. Gross beta activity of airborne particulates, Mexico, March 1965

Station	Number of samples	Gross beta activity (pCi/m³)		
		Maximum	Minimum	Average
Acapulco	19	0.1	<0.1	0.1
Ciudad Juárez	17	0.3	<0.1	0.1
Chihuahua	17	0.5	<0.1	0.2
Ensenada	11	0.4	<0.1	0.2
Guadalajara	9	0.1	<0.1	0.1
Guaymas	5	0.2	<0.1	0.1
La Paz	6	0.6	0.1	0.3
Matamoros*				
Mazatlán*				
Mérida	11	0.3	<0.1	0.1
México, D.F.	13	0.3	<0.1	0.1
Nuevo Laredo*				
San Luis Potosí	13	0.2	<0.1	<0.1
Tampico	17	0.3	<0.1	0.1
Torréon	12	0.4	<0.1	0.2
Tuxtla Gutiérrez*				
Veracruz*				

* Blanks indicate stations temporarily shut down.

5. Pan American Air Sampling Program March 1965

Pan American Health Organization and Public Health Service

Gross beta activity in air is monitored by five countries in the Americas under the auspices of a collaborative program, developed by the Pan American Health Organization and the Public Health Service (PHS), for assisting countries of the Amercias in developing radiological health programs. The sampling equipment and analytical services are provided by the Division of Radiological Health, PHS, and are identical with those employed by the Radiation Surveillance Network (article 1, page 333).

The March 1965 air monitoring results from the five participating countries are given in table 5.

Table 5. Gross beta activity in air, PAHO, March 1965

Sampling stations	Number of samples	Gross beta activity, pCi/m³		
		Maximum	Minimum	Average*
Kingston, Jamaica	17	0.28	<0.10	<0.15
Caracas, Venezuela	23	0.14	<0.10	<0.10
Lima, Peru	19	0.10	<0.10	<0.10
Santiago, Chile	31	0.13	<0.10	<0.10
Trinidad, West Indies	18	0.20	<0.10	<0.12

* The monthly average is calculated by weighting the individual samples with length of sampling period. Values of <0.10 are assumed to be 0.10 for averaging purposes. If the <0.10 values represent more than 10 percent of the values used in the average, a less-than sign is placed in front of the average.

6. Gross beta activity in air, North America March 1965

From January 1963 through November 1964, monthly average concentrations of airborne gross beta activity in Canada and the United States were presented in combined form as isogram maps of most of North America. The data from the Radiation Surveillance Network and the Canadian Air Network were adjusted to each other by means of an intercalibration factor derived by Lockhart and Patterson (*16*).

With the formation of the Mexican Air Monitoring Program, new intercalibration ratios were determined, this time including the Canadian Network, Radiation Surveillance Network, Pan American Air Sampling Program, National Air Sampling Network, the HASL 80th Meridian Network, and the Mexican Network (*17*). The new intercalibration factors reflect some changes in standardization in both the RSN and the Canadian Air Network, effective September 1963.

In recent months, airborne gross beta activities have declined to such low levels that isogram comparisons are no longer meaningful. Before comparison with each other, the data from different networks must be multiplied by appropriate intercalibration factors. For example, if the Canadian data are considered as unity, the RSN and Pan American data must be multiplied by the intercalibration factor, 1.28, and the Mexican data must be multiplied by 0.81.

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